Knowledge

Founded by Richard A. Proctor, 1881.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

CONDUCTED BY

Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

"Let Knowledge grow from more to more."

—*Tennyson.*

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A Monthly Record of Science.

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JANUARY, 1914.

SOLAR SURFACE DISTURBANCES.

By THE REV. A. L. CORTIE, S.J., F.R.A.S.

THE statistical study of sunspots and faculae, their enumeration, and the determination of their positions and areas is all-important, since physical science depends on the sure foundations of exact measurement. In addition to this, the study of the life-histories of the spot-groups and the faculae associated with them, and, further, their coördination with the phenomena observed in the solar atmosphere, are no less necessary if the physics of the Sun and the mode of action of the forces which are in evidence in such disturbances are to be adequately comprehended. Were an observer to examine the Sun's surface at times when sunspots are plentiful, he would be at once struck by the variety of appearances which the spots presented: some as groups of small dots; some as well-developed round spots; others, again, as a brace of more or less developed spots; and others of a medley of spots following a well-defined leader. And yet there is a unity in their seeming variety; for by a comparative study of thousands of sunspots drawn at the Stonyhurst Observatory during the last thirty years it appears that by far the greater number of sunspot groups follow the same phases in their birth, development, and decay, and that the dissimilarity of forms seen on any one day is but a passing type in an orderly progression in the life-history of a group of sunspots. Nor are the individual groups themselves isolated phenomena, but are frequently linked with other groups, which will sometimes disturb, either intermittently or continuously and successively, the same region of the Sun's surface for long periods of time. These disturbed regions are mostly in the form of narrow strips of the surface, containing an area comprised within some 20° in longitude by 5° in latitude, about five thousand six hundred millions of square miles, or one four-hundredth of the Sun's total surface area. For instance, a region of the Sun's surface between the limits 112° and 135° longitude and 9° to 13° south latitude, was intermittently disturbed from January 1st to July 31st, 1897, and then almost continuously from January 19th to July 29th, 1898. A still larger area, extending from 249° to 281° longitude and 13° to 27° south latitude, was the seat of continuous disturbance for five hundred and twenty-seven days, from September 25th, 1891, to March 5th, 1893, and of intermittent disturbance for months afterwards. During this period four spot-groups of the the largest dimensions and thirteen of smaller size appeared on this portion of the Sun's surface.

Such successive disturbances in close proximity to one another are nearly always concomitant with series of magnetic disturbances on the Earth, culminating at times in a magnetic storm of the first order of magnitude. Such was the very great magnetic storm of March 15th, 1898, which was

one of successive sets of magnetic disturbances, occurring in sympathy with the presentment to the Earth, at each of eight synodical solar rotations, of the area of the Sun already referred to as disturbed during the months January to July, 1898. In these cases the magnetic action of the Sun, which is a condition of the occurrence of a storm upon Earth, would seem to be gradual and cumulative, until it attains a disturbing climax. Disturbed areas of the Sun, associated with like series of magnetic storms, have, in the cases of the total solar eclipses of 1893, 1898, 1905, and 1908, been identified with bundles of streamers in the Sun's corona, apparently diverging from the foci of solar disturbance. This concordance is suggestive, as an indication of the mode of propagation of the Sun's influence operative in magnetic storms. But leaving aside for the present these questions of wider import, it is proposed to describe in detail the life-history of a typical outburst of sunspots and the accompanying faculae.

The appearance of a sunspot group is generally preceded by a few flecks of compact brilliant faculae, presumably the signs of an upheaval of the solar surface or photosphere. But as the disturbance may be associated with others, as has been already explained, the spot, when it appears, may be born amidst spreading and diffuse faculae, which do not properly belong to it, but to a preceding disturbance in approximately the same region. The discriminating note is that its own faculae are, in the earlier stages of its life-history, brilliant and compact and closely massed round the newly born spot. The propagation of wave-motion when a stone is dropped into a pond, bears an analogy to the spreading of the faculae around a sunspot disturbance. In the illustrations (from a series of drawings in the Stonyhurst collection) which illustrate this article the spot group will be seen on September 7th, 1884, (see Figure 1) appearing as a few small dots in some old branching faculae, but surrounded by a bright ring of the faculae which properly belong to it. The few small spots marking the region of a disturbance are soon joined by others, which gradually form a train consisting of a principal leader spot and a trailer. This phase generally occurs from five to seven days after the first appearance of the spot, the faculae remaining compact and bright about the group. The beginning and the progress of this stage in the spot's life-history are illustrated in the present case in the drawings of September 10th and September 12th (see Figures 2 and 3). Two groups of spots are shown on the drawing of September 10th (see Figure 2): it is the upper one of the two with which we are concerned, and the subsequent development of which is shown in the succeeding pictures. This is the period in the life-history of a spot-group of great internal activity, which is completed when the spots which fill up the space between the two main spots disappear, leaving the leader and the trailer of the group. It is in this space, between the two main spots, that vivid reversals of the hydrogen lines are frequently seen in the spectroscope. The two main spots are also at this stage often affected by proper motions, independent of and superadded to their normal drift across the Sun's surface proper to the latitude in which they may have appeared. For it is well known, since the classical researches of Carrington on sunspots, that a spot in latitude 14° north or south will have a normal angular velocity of 14°·2 a day in longitude, while spots in higher latitudes will travel more slowly, and those in lower latitudes more quickly. This inequality of rotational velocity with latitude is one of the many puzzles of solar physics. But the proper motion to which reference is now made is something beyond the normal drift, the leader spot frequently advancing forward in longitude, and the following spot receding in an opposite direction, as if the two spots were exercising a repellent action upon each other.

The faculae now begin to branch out from the centre of disturbance, becoming at the same time less brilliant. They sometimes embrace vast areas of the solar surface. The drawing of September 15th (see Figure 4) illustrates the beginning of this tendency to spread in the faculae, which is seen also in those of the next two days. The spot-group is now approaching the Sun's west limb, and on September 17th (see Figure 6) the leader spot, at the Greenwich mean time indicated, is actually on the limb. Is it a saucer-like cavity in the limb, or is it an eminence blocking out the view of a continuous limb? Might not the penumbra of a sunspot represent the shelving sides of a shallow depression, and the umbra a central eminence something like the central peak of a lunar crater? The next drawing, that of October 5th (see Figure 7) shows the group after it has passed round the invisible hemisphere of the Sun, and after its reappearance at the east limb. It will be noticed that the following one of the two spots is breaking up. This usually occurs until it is finally absorbed in or covered by the photosphere, leaving the leader as a single round spot. It may persist in this steady state for another two rotations, surrounded by extensive, though comparatively faint, faculae. This spot also is gradually broken up and disappears as a few small dots, or a single small round spot, recalling, except for the form of the accompanying faculae, its first beginnings; for, whereas the faculae were then compact and bright, they are now diffuse and not so brilliant. This phase is shown in the third reappearance of the spot in the drawing of November 1st (see Figure 8), when one minute spot is seen in the enveloping faculae. At the next rotation, in the drawing of November 28th (see Figure 9), an extensive area of faculae alone remains to mark the seat of the spot disturbance. But the next day a new, though associated, disturbance appears in almost the same latitude, and some two degrees behind in longitude, which is figured when approaching the west

Figure 1. Sept. 7th, 1884. 11h.

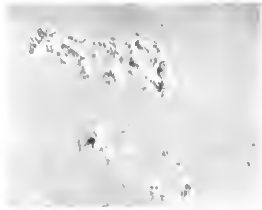


Figure 2. Sept. 10th, 1884. 10h.

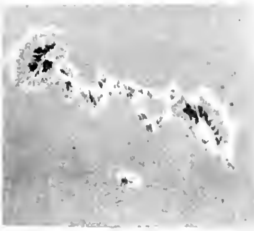


Figure 3. Sept. 12th, 1884. 11h.

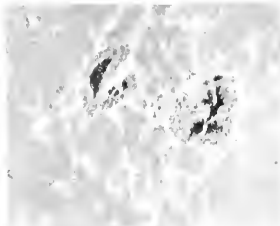


Figure 4. Sept. 15th, 1884. 12h. 30m.

Figure 5. Sept. 16th, 1884. 12h. 30m.

Figure 6. Sept. 17th, 1884. 16h. 0m.

Figure 7. Oct. 5th, 1884. 11h. 0m.

DRAWINGS OF SUNSPOTS MADE IN THE YEAR 1884 FROM THE STONYHURST OBSERVATORY COLLECTION.

[illegible] 1884, [illegible]

[illegible] Nov. 29, 1884, 11h. 0m.

[illegible]

[illegible] Dec. 6, 1884, [illegible]

[illegible] OF [illegible] IN THE YEAR [illegible] FROM THE [illegible] COLLECTION.

limb on December 6th (see Figure 11). It is comparatively easy, therefore, for one who studies the surface of the Sun, and who applies the criteria of the form of the spot-group and of the surrounding faculae, to discriminate between old and new disturbances. Should the spot-group also be in one of its earlier stages of development when it comes into view on the Sun's east limb, it is possible to give the approximate date of its first appearance on the invisible hemisphere of the Sun. The different phases of the life-histories of spots have been summarised in a series of types, with suitable subdivisions, which it is beyond our scope to discuss. These types, as a short description of a spot-group, have been adopted at the solar observatories of Kodaikanal, Tortosa, and Stonyhurst, whence they originated. The group of spots which has been described in the present article can be recognised as group 1480, mean longitude 15·38 and latitude + 14·02, and the recurrent group 1501, mean longitude 15·18 and latitude + 14·18 of the Greenwich sunspot volumes, and the second group which appeared in the same region as group 1517, mean longitude 13·03 and latitude + 13·52.

ENGLISH WOODLAND AND TIMBER INDUSTRIES EXHIBITION, 1914

An important and representative exhibition of woodland and timber industries will be held in London this year, under the auspices of the "English Forestry Association." Invitations to coöperate will be extended to all bodies interested in the subject, and it is hoped to obtain the enthusiastic support of all concerned with English Timber and Underwood, so that a real effort may be made to improve the present unsatisfactory position of affairs.

A special feature of the exhibition will be practical illustrations—showing the men at work—of the Woodland Industries which the Association are organising and encouraging, and especially those dealing with the conversion of coppice and poles.

By organisation and up-to-date methods, effective steps are being taken to compete with foreign supplies, and the Association have spent considerable time in investigating the directions in which such competition may be most successful. No industry will be exhibited which in their opinion is not capable of being made a commercial success.

The importance of woodland industries in providing work for agricultural districts during the winter months cannot be over-estimated, and it is deplorable that in the past such valuable sources of rural employment have been lost for want of organisation. The decay of these woodland industries has contributed very considerably to rural depopulation, and their successful revival would have an important influence upon small holdings and similar movements to attract the labourer back to the land.

Steps have already been taken to revive the wooden barrel-hoop industry. Contrary to popular belief there is still a very large demand in this country for these hoops, which are manufactured from Hazel and other Underwood. Other local industries are being extended and organised for the consumption of other classes of Underwood.

Another special feature of the Exhibition will be illustrations of the present uses and markets for English Timber, and great emphasis will be laid upon new ones that might now be cultivated.

The "English Forestry Association" was formed some years ago to take up the whole question of the marketing and commercial utilisation of English Timber and Underwood. After several years of investigation the Council are satisfied that proper markets for all classes of English Timber and Underwood exist, and can be cultivated, providing that landowners and land agents will coöperate with them.

Wherever sufficient and proper supplies can be ensured, a greatly increased demand is being organised for all classes of English Timber and Underwood, and especially for Oak, Larch, and Scots Pine.

At the coming exhibition all these points will be illustrated, and in order to secure the best results the Council of the "English Forestry Association" invite particulars from Landowners, Land Agents, Timber Merchants and others interested in Woodland Industries.

During the course of the Exhibition, Conferences will be held to discuss important points, and especially with a view of extending the uses of English timber or the goods manufactured from it, as well as to endeavour to overcome some of the initial difficulties.

The Association are publishing leaflets dealing with the many important points with which they are immediately concerned.

The "English Forestry Association" wish to emphasise that they are not a trading association, they do not as a body buy or sell timber, nor charge commission on the sale. Their object is to encourage the use and demand for English Timber and Underwood, and to organise its marketing and assist in its sale, leaving it to the recognised channels to negotiate and to supply that demand. They are not aware of any legitimate interest which will be prejudiced by the steps which they advocate and they invite all who are interested to communicate with the Honorary Secretary, "English Forestry Association," Farnham Common, Slough, Bucks, with a view to making the coming exhibition a success, and helping them to prove that British Timber and British goods, manufactured by British labour, can compete successfully with foreign productions.

A COOL HOUSE FOR TROPICAL HORTICULTURISTS.

By J. HARRIS STONE, M.A., F.L.S., F.C.S

A NURSERYMAN'S business in the Southern States of America is very different in character from what it is here. The reason is not far to seek. The climatic conditions are much more trying, extremes of heat and cold not unfrequently occur, requiring the utmost skill of the scientific gardener to combat and overcome if commercial success is to attend his expenditure of time and money.

Practically quite a new wholesale florist's business has been inaugurated at Dickinson, in Galveston County, Texas, by Mr. Erik E. Stone, who emigrated to the United States some years ago. Mr. Stone had had no previous knowledge of gardening beyond the ordinary amateur's interest in flowers, but he received the ordinary all-round education at Bedford Grammar School, and was always particularly interested in natural history, and especially botany. Taking up a farm of many acres, about nine miles from the thriving port of Galveston, he gradually formed it into a nursery-garden, and took to raising chiefly gardenias, which he grew in long hedges, sending the odorous white blooms all over the States. He would take orders for these blossoms by the thousand, and has supplied requests for as many as ten thousand at a time for the shops at St. Louis, Chicago, and New York. White flowers, he soon found, had a more constant and larger demand than any others; so he concentrated his attention on the supply of such for weddings and funerals all over the States, but strictly as a wholesale merchant. To do a retail trade in flowers, as well as a wholesale, is not politic there, and the latter is more constant and paying.

His difficulty was to keep up his supply to meet the demand all the year round. Flowers are such seasonable commodities that he found he must depart from the usual stereotyped methods in order to be able to meet the trade necessities at all times of the year—winter as well as summer. One of his inventions is a cool house for a hot climate. It is like other greenhouses in so far as the frame goes, but it is different in that it is exactly the opposite of the usual warm house for cool climates. Each house is thirty feet by a hundred, constructed of the well-known Foley pipe frame, with no benches, but four lines of support. The common complaint in Mr. Stone's locality is that the ordinary form of greenhouse gets too hot in the summer. After thinking the matter out for himself he had a special roof built on a standard frame (see Figure 12). Shade was what he wanted. This is how he got it. At the end of the house are three sash bars to carry the glass in the ordinary way; then a bar is admitted and the frame set in; two frames are not glazed, but filled with roofing felt; then three more runs of glass; then a felt frame, and so on, to the other end of the house. Laths of wood are nailed on to a wooden framework, with the width of a lath between and on the sides as well. The beds are bordered with creosoted wood, which, Mr. Stone tells us, does not injure the plants.

These lath-houses keep the hot sun off in summer and the plants warm in winter, and he finds they are admirable for producing all the year round the graceful sprays of *Asparagus plumosus nanus*, which are in constant demand. Mr. Stone says: "I do not raise the plants to sell, but only the sprays, which are cut from them as they mature and are shipped to florists all over the States, who use them in making up flower designs and decorations. The sprays are put up in bunches of twelve or twenty-five, according to the market they are for, and wet paper tied round the stems to keep them on long journeys. They are put up in special boxes, holding from three hundred to five hundred sprays each, or twenty-five to forty-two bunches of twelve sprays. The boxes are well lined with old newspapers first. I buy my newspapers by the hundred pounds, and use quantities of them. There is a reason for this—not because the old papers are cheap, but that there has not yet been found anything so good to hold moisture in and keep hot and cold air out. Nothing beats an old newspaper when it comes to packing plants or flowers." Mr. Stone raises his *Asparagus plumosus* plants from seeds, and cuts from them in two years, when they will produce good sprays for four or five years. In winter the tops often get frozen off, but the plants put up new shoots in about six weeks or two months, according to the weather, the roots being very seldom killed. Figure 13 shows the interior of one of these shade-houses, where each compartment of plants is numbered. The history of each of the groups is carefully recorded, the manure used and general treatment, and so on, in order that the best and most economical method may be evolved and the inferior discarded.

Mr. Stone, to use the American expression, is doing a "bumper" business at Dickinson, and a visit to his glasshouses, lath-houses, beds, and hot and cool houses makes one feel inclined to go in for this delightful business. There is a system in the way things are run about the place, for every detail is under the personal supervision of the proprietor, and must be done just right, or else it is considered worse than useless. Among the ornamental trees and shrubs grown by Mr. Stone are several varieties of cedars, camphor trees,

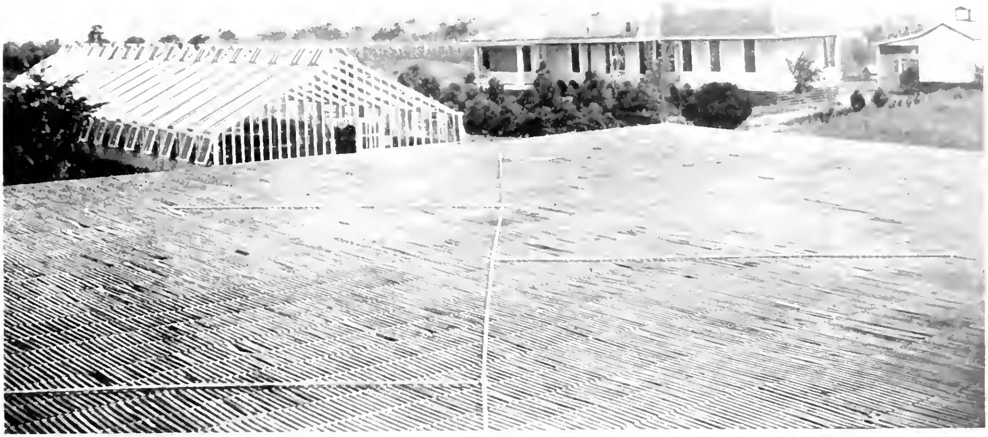
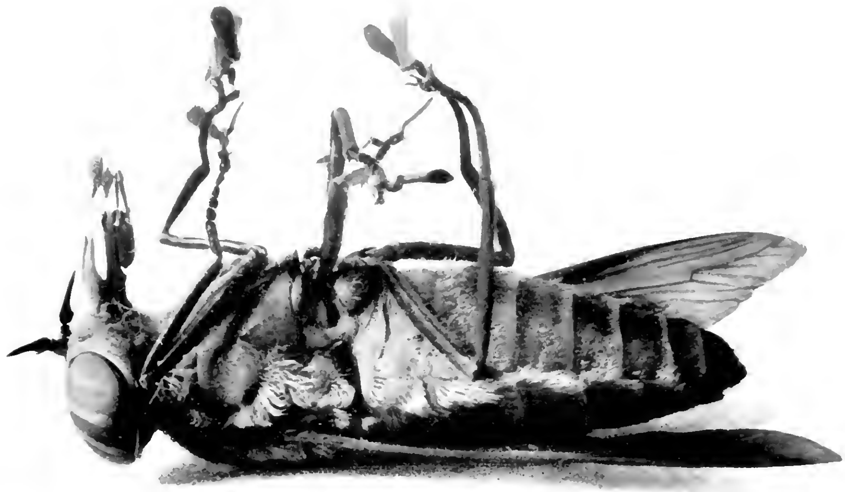


FIGURE 12. General view of part of Mr. E. E. Stone's Nursery at Dickinson, in Galveston County, Texas, U.S.A., [illegible] roof of a Shade-house in the foreground.

FIGURE 13. Shade-house [illegible] Dickinson. Mr. E. E. Stone [illegible] [illegible] [illegible] [illegible] Ferns.



Macnamara.

FIGURE 14.

Tabanus sp. with pollinia of *Asclepias syriaca* attached to its feet and proboscis. × 7.

Arabian tallow trees of the Loras variety, Mexican single tube-roses, and jessamines. Under the lath-houses and combination houses he has always about fifteen thousand *Asparagus plumosus* plants alone. From his thousand young jessamine trees, blooming this past season for the second time, he shipped more than half a million blossoms. So well did he realise from these that he has made arrangements to plant several thousand more of the plants, and engage in growing the flowers for the market in a more extensive way.

About the gardens there are four gas-engines, lifting water into the high-level tanks and operating the complete workshop of the place. For sport Mr. Stone has almost at his doors plenty of wild-duck shooting and alligator hunting, so that he combines pleasure with his other and more remunerative occupations.

THE PHYSICAL SOCIETY'S EXHIBITION.

THE Physical Society of London held their ninth Annual Exhibition of Electrical, Optical, and other Physical apparatus, at the Imperial College of Science, on December 16th, 1913.

Experimental demonstrations were given at intervals throughout the afternoon and evening of the Band Spectrum of Helium, of Ionisation by Collision, of the Interference of X-rays by crystals, and many other interesting phenomena: while in the two lecture-theatres, Professor J. A. Fleming, D.Sc., F.R.S., discoursed on the Production of Vibrations on Loaded and Unloaded Strings, and Mr. Louis Brennan, C.B., on the "Iridiscope" and some Experiments on Soap Films. The latter lecturer made an appeal to the aesthetic as well as the scientific sense, for the colours displayed by the delicate films ingeniously stretched on the iridiscope were exquisite both in their variety and intensity. These colours, as explained by Mr. Brennan, are due to interference and accordingly change with the ever-varying thickness, or rather thinness, of the soap films, which although almost inconceivably thin nevertheless exhibit such marvellous tenacity that they will endure a fairly strong blast from a blowpipe before rupturing. Curious and very beautiful effects were produced when the lecturer introduced a hair, the ends of which had previously been cemented together, into the film. On applying the blowpipe to the centre of the ring thus formed the film was ruptured within the circle, so that a round hole, bounded by the hair, was produced. This hole could be made to swim about the film in a remarkable way by blowing upon it, and when two holes were produced in the manner described the result was very curious indeed, the two round vacuities revolving about each other something after the fashion of a double star.

A vast array of instrumental exhibits was to be seen in the various rooms, and astronomers in particular found much to interest them in the display of astrophysical apparatus. Messrs. R. and J. Beck, Ltd. showed, in addition to their well-known microscopes, several examples of Thorpe diffraction gratings—replicas of the Rowland's Gratings cast in celluloid from the original rulings—viewed under the microscope.

Microscopes of various patterns were exhibited by Messrs. Zeiss, Leitz, and Swift, the new binocular microscope available for objectives of the highest powers (including oil-immersion objectives) of Messrs. E. Leitz attracting especial attention. A slide of Trypanosomes was exhibited under one of these, and all the details of this micro-organism were shown with wonderful precision.

An interesting instrument exhibited by the courtesy of Messrs. Vickers, Ltd., was the "Ripograph." This was a copy, with additions, of an instrument designed and made at the Royal Aircraft Factory. The apparatus, when carried on an aeroplane, records, simultaneously, nine different quantities, and thus enables the behaviour of the aeroplane to be thoroughly examined.

Messrs. A. C. Cossor, Ltd., showed new forms of X-ray tubes with Iridium Targets, and with Lithium glass.

Other interesting apparatus by Messrs. Adam Hilger, Ltd., and Messrs. Newton & Company, attracted much attention. The first-named firm showed their Quartz Monochromatic Illuminator of large effective aperture for the ultra-violet, reading from 200 $\mu\mu$ to 700 $\mu\mu$ direct in wave-lengths, and their ingenious Spectro-Comparator, especially designed for the accurate comparison and measurement of spectrograms.

Practical utility was duly considered in many of the exhibits, and mention must be made of the installations shown by the Marconi Wireless Telegraph Company, Ltd.; but one of the items most calculated to benefit the man in the street was perhaps the demonstration given by Messrs. Clifford C. Paterson and B. P. Dudding of a proposal for mitigating the dazzle caused by motor car head-lights.

THE NATURE PHOTOGRAPHIC SOCIETY'S EXHIBITION.

WE have the pleasure of reproducing (see Figure 14 on page 8) another interesting picture which was shown at the Nature Photographic Society's Exhibition, of which we gave an account in the last number of "KNOWLEDGE." It is by Mr. Charles Macnamara, of a species of gadfly, bearing pollinia on its feet.

STELLAR SPECTROSCOPY FOR BEGINNERS. III.

By PROFESSOR A. W. BICKERTON, A.R.S.M.

The Spectroscope.

Spectroscopes are of two principal kinds, generally called "integrating" and "analysing"; but, as the spectroscope used in analyses is generally an integrating one, perhaps the best terms to use

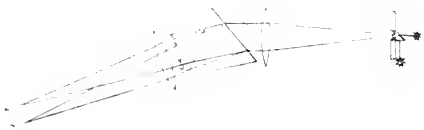


Figure 15.

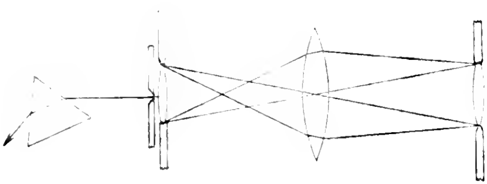


Figure 16.

would be "integrating" and "differentiating" spectroscopes. The former presents all the rays from an object collected together. The differentiating spectroscope allows the several parts of an object to be examined separately. The camera, or telescope, armed with a prism, but not having a slit, is a differential spectroscope. Or the object to be examined may have its image focused upon the slit of a spectroscope, so that different parts of the object may be separately examined. An integrating spectroscope then becomes analysing or differential. An interesting example of this change is the mode of looking at the so-called long and short lines of an element. If an electric arc be placed at right angles in front of the slit of a spectroscope the whole light will show on the spectrogram. If a lens be interposed as in Figure 16 the middle or each end can be separately examined. The diagram shows the middle of the arc being examined. Figures 15 and 16 show the very different effect on the various overtones.

Stars have no disc; hence, even without a slit, all spectrograms of stars are integrated. The parts of a star cannot be differentiated. In fact, the spectrum of a star is a straight line, and the Fraunhofer lines but black dots. A cylindrical lens is used in the eyepiece of the telescope to make these dots into lines. When spectrograms—that is, photospectra—are taken, the plate is sometimes moved at right angles to the spectrum, or the plate rocked to give width to the lines in an enlargement. All the spectra in the plates of the first article are integrated spectra. Mr. Worthington's spectrum that was given in the December number of "Knowledge" is a differentiated one.

Divergent Rays.

During an eclipse of the Sun along a shaded path every chink of the foliage that allows a sunbeam to pass through produces an image on the path of the eclipsed Sun.

A very pretty way of showing an eclipse of the Sun is to cover a window with brown paper and pierce small holes of any shape through the paper. If a white screen be placed across the rays at some distance from the holes, images of the eclipse are seen, no matter what are the shapes of the holes, whether they be round or square or triangular. The image gets bigger and less like the hole the farther the screen is from the opening. The rays diverge in the same way from a spectroscope slit, and a lens is used to make the rays entering the prism parallel: this is called a collimating lens. After passing the prism a small telescope is used to bring the parallel rays of each tint to its focus. As the rays are differently bent the telescope has to be moved around in order to see each in succession.

Half the length of the slit may be covered with a totally reflecting prism to bring into comparison

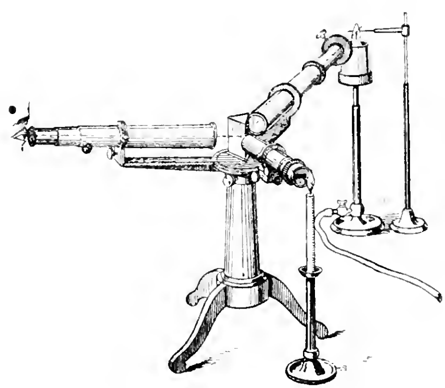
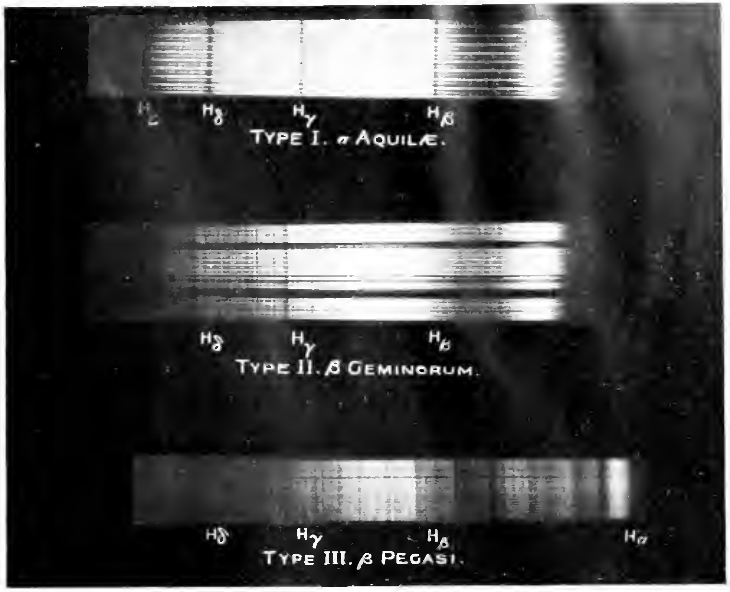


Figure 17.

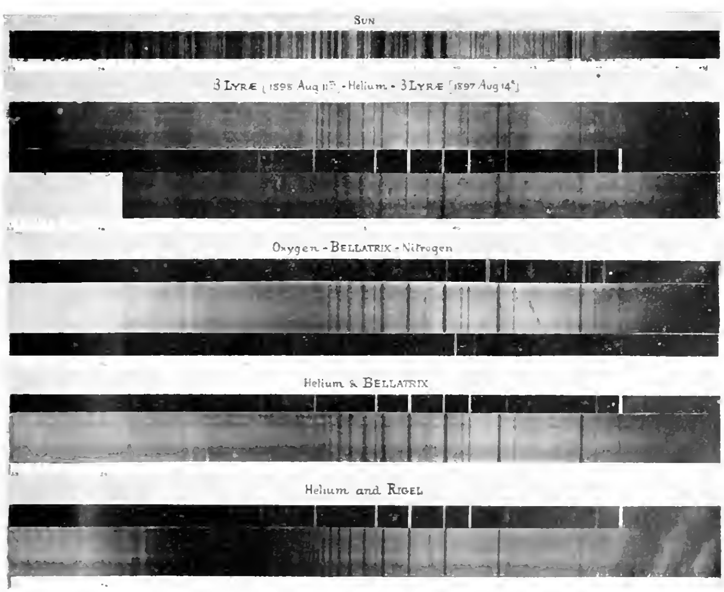
light from a known source. This enables an element to be recognised. Figure 15 represents the arrangement; only two wave-lengths are shown, red and green; a perspective picture of the whole apparatus



From spectrograms ...

FIGURE ...

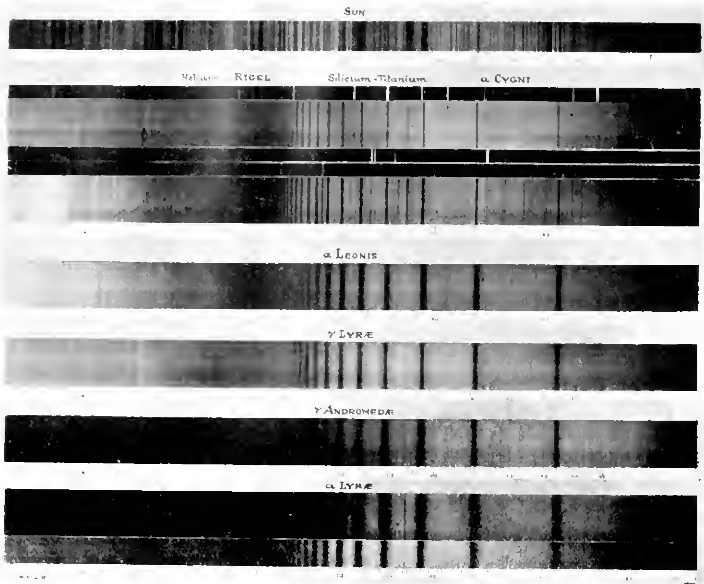
Spectra showing the point of light of the star drawn out into horizontal lines by a prism: the black vertical lines are a series of dots, each one produced by a shift of the image of the star on the photographic plate.



From spectrograms ...

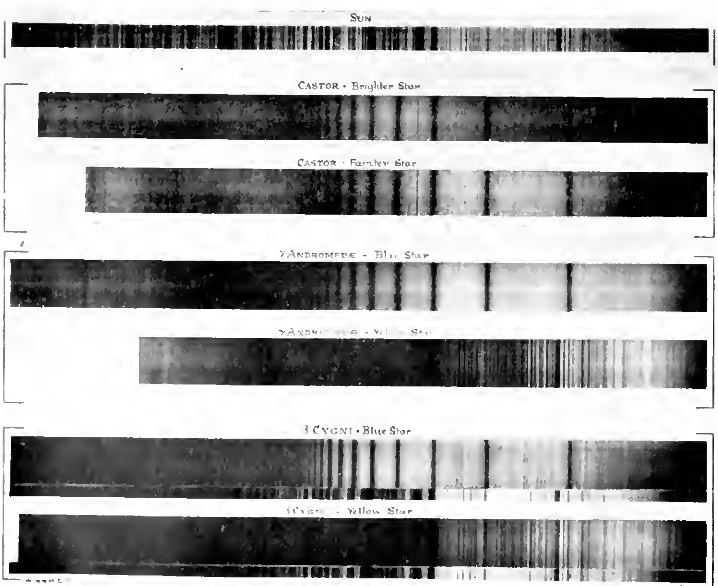
FIGURE 1...

Example of integrated spectra: the light is collected from the whole of the ... body



William Huggins, Tulse Hill.

FIGURE 20.



William Huggins, Tulse Hill.

FIGURE 21.

Spectrograms showing well the definite harmonic character of the overtones of the element hydrogen.

is shown in Figure 17. In this, a scale is reflected instead of a known element. Cross wires are placed in the telescope, and a graduated scale is attached to the stand to enable the exact position of the line to be read off.

OBSERVING POWER.

I once had a student who could see lines in the ultra-violet part of the spectrum of which no one else could see a sign. To test him we read the vernier scale, and then let him fix the cross wires over the ultra-violet line again, and the reading was exactly the same as before. Some students are slightly colour-blind, and have a great difficulty in reading the red end of the spectrum. Besides these there are other great differences in observing power, both telescopic and spectroscopic. Some observers can catch a faint point of light like a planet's moon or a small asteroid, and others such delicate lines as the complex markings on Mars. Training has an immense deal of importance in this respect. A person for weeks may not see the so-called canals on Mars, yet when once they are seen they are afterwards easily recognised and drawn, and differently trained observers will draw them alike. Probably, however, the full comprehension of a good working hypothesis is the very best aid of all in the discovery of truths of any kind. Of course, there is seeing what one looks for when it is not there. There are many ways of testing such false seeing, such as comparison of different observers' drawings, and photography. There are also researches in which the eye is best, and others in which the photographic film is altogether the most powerful, as already noticed.

GRATINGS AND WAVE-LENGTHS.

Before studying celestial phenomena we had best understand the effect on light of gratings as well as prisms.*

Sometimes in early morning brilliant colours are seen flashing from sunlit dewdrops. The water sphere is sorting the light into its constituents. The beauty of sunlight pulled to pieces is seen in the diamond and the lustres of chandeliers: these are all examples of prismatic colours, but sunlight can be pulled to pieces by closely ruled lines called "gratings." The loveliness of a grating is seen in mother-of-pearl and in the rainbow button, both of which are covered with fine, close, parallel lines. The colours of a prism are due to the different refractions of the waves. The colours of a diffraction grating are due to the effect of two waves of light on each other, and is called "interference," or "diffraction." Interference effects are also seen in the colours of a soap-bubble, in the changing tints when steel is tempered, and when oil is placed on water. These are called the colours of thin plates. A very pretty way of studying these phenomena is to overload one of Professor Boys's Rainbow Tops, and keep spinning it; then carefully noticing the successive changes of colour at the centre. An extraordinary number of important phenomena can be learnt from this wonderful toy.

THE EXPLANATION OF INTERFERENCE AND DIFFERENTIATION.

Suppose two equal impulses be given to a particle of ether, one to push it up and the other to press it down; clearly the particle stands still.

If we have two sources of the same pure tint, the two impulses may push the ether particle the same way and increase the intensity of the light, or they may be half a wave-length different in phase—then the colour is obliterated.

Suppose we have white light made of pure green and pure red, and there is a reflection from the front and back surface of the film of a bubble; the two reflections of the red may be half a wave-length different, and will interfere and be destroyed; the green would then show. Suppose the film became thinner, and the two green reflections were half a wave-length out; the green would be destroyed and the red would show. Thus is explained the colours of thin plates.

In the case of a grating of thousands of close lines the light tends to spread fanwise through each space; the oblique reflection, or transmission from the different openings or surfaces, will be half a wave-length out for some tints, and whole wave-lengths different for others. With common white light the exact angle at which the reflection, or transmitted beams, are whole wave-lengths out give brilliant colours. These various wave-lengths are collected by a lens (see Figure 22). A different wave-length would be focused in a different position, as a different angle would produce a whole wave-length.

MAPS OF SPECTRA.

Prisms of different glass bend the light in different ratios; hence prismatic dispersion tells us but little of the actual lengths of the wave, and spectra maps prepared from them are of much less value than grating maps. Fraunhofer noticed this, and took extraordinary trouble to prepare gratings so accurate as to enable him to measure the waves of light. This wonderful genius, who was apprenticed to a looking-glass maker, died before the age of forty; yet he laid the foundations of modern spectroscopy. He mapped five hundred and seventy-six of the Sun's lines; was the first to make and use gratings for perfect spectra and to measure the wave-lengths of light. He suggested that the D lines were produced by sodium, and made most wonderful microscopic and telescopic lenses, so that his epitaph, "He brought the stars nearer," was well deserved, even more so than anyone would then have thought. Notice the scales in Figure 123 in "KNOWLEDGE," Volume XXXVI (1913). The divisions vary in length because the photographs were taken through a prism.

In modern days Fraunhofer's spectra maps have

been greatly improved by many, especially by Angström and Rowland.

Wave-length Units.

Gratings are made of glass and of metal. Fraunhofer drew exquisitely close lines, with a diamond, on glass. Our modern gratings run from ten thousand to twenty thousand lines to the inch.

A table, or map, of solar lines, numbering over twenty thousand, has been prepared by Rowland.

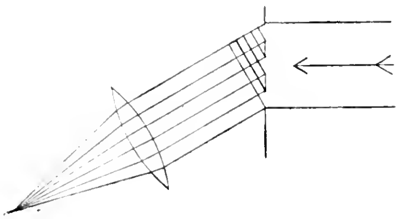


Figure 22.

Angström used as units of wave-lengths the ten millionth part of a millimetre: these are called "tenth metres," or $\frac{1}{10^{10}} = \frac{1}{10,000,000,000}$ of a metre, also called Angström units, and are signified by A.U. Thus the crimson hydrogen line, the line indicated by Fraunhofer as C, and now more usually as H_a, has wave-length 6563 A.U.; and D, the longest yellow sodium line, has 5896 A.U.

Rowland divided the A.U. units into one thousand parts; and the two above lines, C and D, became, with greater precision, C 6563·954 and D 5896·154. The ordinary range of the spectrum is indicated by the distance from the line A 7594 A.U. to the broad diffused line of calcium K 3934 A.U.

In the November and December numbers of "Knowledge" the scales attached to the several spectra show the Angström units, and also show that these spectra are chiefly of short wave-lengths; the ordinary photographic plate being, as already explained, much more sensitive to the short than to the long wave-lengths.

It is well to remember that there are two ways of looking at the dimensions of waves: their frequency and length. The greater the frequency the shorter the wave. It is the wave-length that is generally used, but sometimes in studying the systems of the spectrum line of an element the frequency throws light on the harmonic character of overtones. The shorter the wave-length the greater the frequency, and *vice versa*. The relations are well shown by the curve called the rectangular hyperbola (see Figure 23). The upright lines represent wave-frequencies, and the horizontal lines the wave-lengths. A few lines are drawn showing the approximate relations. The Y square and the R and V rectangles are all equal in area.

In all cases the rectangles made by multiplying the two are equal to one another.

The parabola and rectangular hyperbola are extremely useful in spectroscopy, and, in fact, in physics generally. A few words will be said about these conics in the next article.

A first look at stellar spectrograms (the wonderful photographic cyphers by which the stars tell us their story) seems to show us a hopeless jumble of lines, and to the eye they are bands of many colours on a continuous spectrum. Some lines are bright and some dark; some broad and diffused; some sharp and narrow.

Except the wonderful hydrogen band seen in the pre-solar stars in "Knowledge," Volume XXXVI (1913), Figure 423, all the lines seem to be without order; but the clear and obvious harmony in the black bands in those stars furnished a first key to unlock the mysteries. Key after key has been found since. All is not yet understood; but already a wonderful order has evolved from the apparent chaos. When astronomers also use the powerful cosmic key of the third body, the cipher of the complex stellar spectrum will be an open book, telling us in its first amazing outlines the cycle of the eternal heavens.

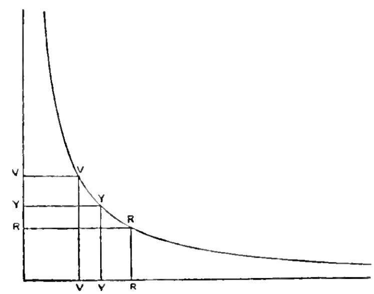


Figure 23.

BRITISH ASSOCIATION GRANTS.

The Council of the British Association, acting under authority of the General Committee, has made the following grants out of the gift of £10,000 made to the Association for scientific purposes by Sir J. K. Caird at the Dundee meeting of the Association last year.

1. £500 to the Committee on Radiotelegraphic Investigations.
2. An annual grant of £100 to the Committee on Seismological Investigations, which is carrying on the work of the late Professor John Milne, F.R.S.
3. An annual grant of £100 to the Committee appointed to select and assist investigators to carry on work at the zoölogical station at Naples.
4. £250 towards the cost of the magnetic re-survey of the British Isles, which has been undertaken by the Royal Society and the British Association in collaboration.

PALAEOBOTANY: ITS PAST AND ITS FUTURE.*

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There was once a time when anthropology claimed privilege as "the youngest of the sciences." To-day Palaeobotany holds that inglorious place. Indeed, Palaeobotany is so exceedingly young a science that I fear that most people, even most palaeobotanists, will scarcely allow that it exists independently at all. This is because it is one of the borderland studies whose boundaries lie between several others, and consequently it is partially known to each of the more condensed, older-established provinces whose territory it touches. Palaeobotany is thus comparable to physical chemistry or astral physics; it is a new science resulting from the combination and extension of two or more older ones.

The botanical side of our science has safely passed through its early struggles, and, thanks to the work of a number of distinguished men, some of whom I shall have occasion to mention later, is to-day eagerly claimed by its once antagonistic step-mother, Botany. The geological side of the subject is still rather scornfully annexed by Geology, and the rest of the science—what might be called the cement of the whole superstructure—is neglected by *both* Palaeophytologia's step-parents, and left in the hands of one or two isolated people.

I do not know whether anyone has ever quite clearly, unequivocally, and determinedly enunciated the fact that *Palaeobotany is an independent science.* In any case, that is what I wish now to emphasise; indeed, an attempt to drive that statement home is the *raison d'être* of this paper.

Palaeobotany has already passed through three main phases of its development: the first, when fossil plants were supposed to be the spontaneous ornamentations of stones by an exuberant Nature which blindly disported itself; the second, when they were realised as being the remains of extinct life, but were described without the light of a fundamental and unifying hypothesis; and the third, when a scientific knowledge of their structure made comparison with recent plants possible, and it was realised that they threw light on the evolution both of the living plants and the existing continents. In this phase we are now at work.

As we are all evolutionists the past as well as the future of our science interests us, and with the past let me deal first, dallying a while in the delightful shades of the tortuous paths of mediaeval progress.

On turning to the early books on geological and botanical science it is rather surprising to find how few and scanty are the references to plant fossils. It seems unlikely that even the most primitive people could never have noticed such striking objects as the ribbed casts of Calamites. Sometimes the trunks are washed out of cliffs, so that they look like pillars from an ancient temple; and even the smaller branches, preserved as deeply ribbed sandstone casts, are so conspicuous that it seems certain they must have attracted the attention even of savages. Yet the only fossil known to me whose history indicates that it may possibly have interested prehistoric man is *Cycadeoidea etrusca*, a specimen which Capellini describes as having been found while excavating an Etruscan tomb.

Leonardo da Vinci, in the early sixteenth century, was perhaps the first to give anything like a scientific explanation of fossils (see Richter's Ed., 1883), but he does not specially mention fossil plants. In the edition of Gerard's "Herbal" published in 1597, there is one reference to mineralised wood, which he calls *Ligna Lapidea* and figures as a stump standing in water. His words are worth quoting: "Among the wonders of England this is one of great admiration, and contrary unto man's reason and capacitie, that there should bee a kinde of Wood alterable into the hardnesse of a stone called Stonie Wood, or rather a kinde of water, which hardeneth Wood and other things into the nature and matter of stones."

In the old literature to which I have had access there is a long gap of nearly a century from 1597 before there occur other references worth quoting.

Even at a time when the petrifications of animal shells were exciting much discussion the early references to plant fossils were few and scanty. I think this is not perhaps surprising. To the unscientific and uncritical minds of the fifteenth and sixteenth centuries there must have seemed nothing unnatural in the impression of a fern or leaf upon a rock. In autumn one may often find leaves closely adhering to stones in a way that is suggestive of a fossil impression, and such a comparison would have immediately lulled a mediaeval mind had it noticed a fossil plant. As vegetation covers the rocks and soil there would have appeared nothing very startling in the discovery of leaves printed on a piece of rock while

* Inaugural Lecture at University College, London. Dr. Teall, F.R.S., F.G.S., Director of H.M. Geological Survey, in the chair.

it was soft or wet. What stirred the first enquiries into the nature of fossils and led to elaborate discussions about the Flood were sea-shells found high and dry on the hillsides.

Robert Hooke's famous explorations with his microscope led him to take an interest in fossil wood, and in his "Micrographia" (1665) we find a plate illustrating part of a section of petrified wood so far as he could see its structure. He devotes five pages to a careful consideration of this and other fossils, and concludes that such "figur'd stones" should be collected and studied further.

In 1693 John Ray, in his "Three Physico-Theological Discourses," devotes some time to demonstrating that wanton ornament is not in Nature's way. He then goes on to consider animal shells, and concludes that *they* are not accidental; for he says: "That Nature should form real shells, without any design of covering an Animal, is indeed so contrary to that innate Prolepsis we have of the Prudence of Nature, (that is, of the Author of Nature) that without doing some Violence to our Faculties, we can hardly prevail with ourselves to believe it." Nevertheless, he did not realise that fossil *plants* were real fossils; for even after demonstrating Nature's abhorrence of wanton ornament he continues: "Yet I must not dissemble, that there is a *Phaenomenon* in Nature, which doth somewhat puzzle me to reconcile with the prudence observable in all its works; and seems strongly to prove, that Nature doth sometimes *ludere,* and delineate Figures, for no other end but for the Ornamentation of some Stones, to entertain and gratifie our Curiosity, or exercise our Wits. That is, those elegant Impressions of the Leaves of Plants upon Cole-Slate."

In 1695 Dr. John Woodward's famous "Essay toward a Natural History of the Earth" took the Deluge of Noah as a fact, and critically considered the time of its advent. The chief importance of Woodward's work is his firm and reasoned insistence that fossils were truly the remains of organic creatures, and not mere "natural fossils," as at that time crystals, minerals, and so on, were called.

Woodward's general account of what happened at the time of the Deluge is of as much interest to fossil botanists as to animal palaeontologists. One passage is worth quoting. He says: "That the whole Terrestrial Globe was taken all to pieces and dissolv'd at the Deluge; the Particles of Stone, Marble, and all other solids dissever'd . . . as also all Animal Bodies, and Parts of Animals, Bones, Teeth, Shells, Vegetables and Parts of Vegetables, Trees, Shrubs, Herbs, and to be short, all Bodies whatsoever that were upon the Earth, or that constituted the Mass of it; if not quite down to the Abyss, yet at least to the greatest depth we ever dig: (that is, if not to the Depth of two thousand Miles, at least two hundred feet) . . . I say, all these were assum'd up promiscuously into the Water, and sustained in it in such manner, that the Water and Bodies in it together made up one common confus'd Mass."

Woodward goes on to explain that it all settled down according to gravity in layers which he called "strata."

In 1697 "F.A.M.D." published a criticism of Woodward which is of interest to fossil botanists, for he makes particular use of the plants in his argument. He says: "Had this Earth been so dissolved only so far as the Roots of the greatest Plants reach, we must have lost most of the *species* of Plants which were before the Deluge. The Doctor (that is, John Woodward) tells us, that after the Subsidence the plants, being lighter than stone, would be in strata near the surface, Trees, and the other more tender Vegetables shrubs and Herbs would rot and Decay; but the Seeds of all kinds of Vegetables being by this means repos'd, and as it were planted near the Surface of the Earth, in a convenient and Natural Soil, amongst Matter proper for the Formation of Vegetables, would germinate, grow up and replenish the Earth."

Till reading this I confess that it had never struck me that Noah's Ark only contained the *animals* which went in two by two, and that the existence of plant life at all after the Deluge had to be accounted for somehow by mediaeval naturalists.

Woodward's critic gives an admirable picture of the mental attitude of those times toward the subject. He says, in reply to Woodward's easy solution for the continuation of vegetable life after the Flood: "The seeds of all kinds of Vegetables could not be preserved, for some Plants had not yet seeded at the time of the Deluge . . . the Deluge happening, according to the Doctor in the month of *May,* few Plants must have remain'd, but such as were seeded at the beginning of the month." He continues to develop his argument against Woodward's hypothesis that the stratification of the rocks depends simply on the settling of the sediment in layers according to gravity, and concludes that "tho' Dr. Woodward's Hypothesis seems to be liable to many just Exceptions, the whole is not to be exploded."

In 1699 I find the earliest really good figures of fossil plants in the first edition of Edward Luidi or Lloyd's "Lithophylacii Britannici Ichenographia." Calamite foliage is well drawn and described under the old name *Aparineae,* or *Lithophyton radiosum.* It is worth noticing that the date of this plate is 1699; for Seward says that the oldest figures of fossil plants from English rocks drawn with any degree of accuracy are found in Lloyd's book, published in 1760. The 1760 volume is a second edition. So that in this connection I may notice that Scheuchzer's famous "Herbarium Diluvianum," published in 1709, contains beautiful figures of several English coal-measure fossils, which are additionally interesting because they were given to Scheuchzer by John Woodward himself.

The year before Scheuchzer's book was published, in 1708, some good figures of fossil plants appeared in the "Historia Lapidum Figuratorum Helvetiae," and Baier, also in the same year, figures Dicotyledonous leaf impressions, which he described as "*Quercus et Fagi dicto modo Petrifacta.*"

In 1709 Scheuchzer's "Herbarium Diluvianum" appeared, and it may justly be considered the earliest text-book on fossil botany. The first edition consisted of forty-four pages and ten plates, and fourteen years later it was enlarged by the addition of a copious appendix, further plates, and an index.

The illustrations of some of the specimens are excellent. Figures 3 and 4 on Plate I and No. 3 on Plate X are among the good drawings of specimens given by Woodward and coming from the English coal measures.

In 1720 we have a number of plates of fossil plants in Volkmann's "Silesia Subterranea": they include what seem to be the first good illustrations of *Stigmaria* and a number of fair illustrations of various plants, but his figures of *Lepidodendron* and *Sigillaria* are exceedingly poor. Beuth's extraordinarily beautiful figures of these plants were published in 1776, and challenge comparison with Volkmann's because Beuth refers to the earlier plates.

Among pioneers of Palaeobotany it is surprising to discover a man so famous in another sphere as the great mystic, Swedenborg; yet it is true that so early as 1722 he published a plate in his "Miscellanea Observata" illustrating the first fossil plants described in Sweden, a country which counts among its honoured citizens to-day Professor Nathorst, who is perhaps the most distinguished, and certainly the most many-sided, palaeobotanist now living.

From the time of Woodward onwards there has been little backsliding into the morass of belief that fossil plants were accidental, and from his day the external *impressions* of plants were generally recognised as organic fossils. But internal petrifications, which are now so important to palaeobotanists, were, except for Hooke, not studied till much later, so that it is interesting to find that so early as 1732 one Silas Taylor, gentleman, in his "History and Antiquities of Harwich," spends some time on the consideration of petrified woods. He elaborately examines the differences between fossil and living wood, which he notes are externally so alike, and formulates the points of distinction between them. He incorporates whole passages from Robert Hooke, as, for example, when he says that fossil differs from recent wood "in its Incombustibleness, in that it would not burn in the Fire; nay, though I kept it a good while red-hot in the Flame of a Lamp, made very intense by the Blast of a very small Pipe, and a large Charcoal, yet it seemed not at all to have diminished in extension." He follows this up with a curiously worded but acute account of his views of the entry of petrifying solutions and grains into all the pores of the wood.

In 1781 W. Jones published an amusing book, which would perhaps be scarcely worth mentioning here except for the fact that he drew one or two surprisingly good conclusions from his mediaeval data. His book is called "Physiological Disquisitions, or Discourses on the Natural Philosophy of the Elements," and is divided into sections, the first on matter, the second on motion, the third on the elements, and so on, the sixth on sound and music, and the seventh on fossil bodies. He says, in the latter section, that "Fragments of wood are very often found in the strata of the earth. . . . The Armenians and Persians have a tradition that the ark of Noah rested on this or that mountain in their neighbourhood, because fragments of wood are found there turned into stone. That there may be petrified wood in their mountains is easy to be credited, because we have so much of it here: and it is all from the same original. It is all of the same age with Noah's ark, but never made a part of it, because the ark, when stranded after the settlement of the postdiluvian earth, must have been exposed to the air, and consequently must have perished in no great number of years."

In another place he says: "It may be said that fossil plants are no more than accidental lineaments in the stone . . . but . . . we have a mass of fossil plants from a coal mine near Bristol in which it is evident that the leaves were real; for some are doubled backwards and folded over others of a different sort; which could not have happened if they were no more than accidental figures on the stone."

From these two quotations it will be seen that their author had in him the makings of a modern palaeobotanist.

In 1755 and 1771 we have Knorr and Walch illustrating fossil plants with good drawings, and in 1767 a catalogue *raisonné*, published by M. Davila, shows some advance in classifying fossil plants under four headings, viz., the woods or *Dendrolites*, the plants themselves or *Phytolites*, the leaves or *Bibliolites*, and the fruits or *Carpolites*. Nevertheless, the end of the eighteenth century was a dull time for fossil botanists; Palaeobotany was merely marking time awaiting the advent of Brongniart and his famous "Histoire." The "Histoire des Plantes Fossiles," however, did not appear on the horizon completed, like Aphrodite rising from the waves, as the bibliographies of some English palaeobotanists would lead us to suppose, but was published in fifteen separate parts from 1828 to 1838, and was never finished.

Before entering the new epoch created by Brongniart, however, we must refer to one more eighteenth-century book, for it illustrates the fact that it was very long after fossil plants had been recognised and studied that coal itself was realised to be merely fossil plants in bulk. In 1799, in Kirwan's "Geological Essays," we find the following amusing

paragraphs: "It appears to me highly probable that real mineral coal does not originate from vegetable substances of any sort; the resemblance observed between bituminated carbonated wood and mineral coal arises from the similarity of their *composition*, both being formed of carbon and bitumen, but by no means evinces the *filiation* of the latter from the former." He goes on to explain that "carbonic substance and petrol . . . are derived from the primordial chaotic fluid." He says: "Natural carbon was originally contained in many mountains of the granitic and porphyritic order; . . . both petrol and carbon are often contained in *trap*, since horneblende very frequently enters into its composition. My opinion, therefore, is that coal mines or strata of coal, as well as the mountains or hills in which they are found, owe their origin to the disintegration and decomposition of primaeval mountains, either now totally destroyed or whose height and bulk, in consequence of such disintegration, are now considerably lessened . . . the seams of coals themselves and their attendant strata must have resulted from the equable diffusion of the disintegrated particles of the primitive mountains, successively carried down by the gentle trickling of the numerous rills that flowed from those mountains, and in many cases more widely diffused by more copious streams."

But we must leave these fascinating hypotheses and turn to the early years of the eighteen hundreds. Schlotheim, Sternberg, and pre-eminently Brongniart, formed a constellation whose work ushered in a new epoch for our science. In their work, indeed, much, not only of the present investigations, but of Palaeobotany of all time, finds its foundation.

To take, for example, the nomenclature of fossil plants: there are remarkably few generic or specific names which go back earlier than the work of these writers, and at the same time, what is even more surprising, there are comparatively few main groups of fossil plants which they had not recognised. Indeed, one almost gets into the way of assuming that all such well-known names as *Lepidodendron*, *Sigillaria*, *Sphenopteris*, and so on, were founded by one or other of these famous men between the years 1820 and 1832, so that I was much surprised when going through all the old books on which I could lay hands when preparing this lecture to find that so early as 1602 the name "*Calamites*" was in use. In a Latin book of that date, entitled "De Metallicis Libri," we read: "Dicamus autem primo deiis qui ex plantis, et animalibus ortum ducunt Syringites, Calamites, et Phycites, apud Plinium et Theophrastum, videtur fructices corallii modo in lapidem conversi."

But this is by the way. The main fact to notice is that at the beginning of the nineteenth century Palaeobotany suddenly became scientific. In 1828 Sprengel described silicified fern stems from their anatomical structure. In 1833 Witham published his book on "The Internal Structure of Fossil Vegetables," and this was shortly followed by a large work giving beautiful drawings of the anatomy of *Psaronius* and other fossils by Corda, who never seems to me to have received proper appreciation in this country. The leading Continental workers I have mentioned were rapidly joined by many others, among whom may be noted Lindley and Hutton in our own country. As a forerunner of the newer type of work which crystallised round Williamson one may here place Sir Joseph Hooker, who was much interested in and published several valuable papers on the structure of fossil plants, and who held from 1846 to 1848 the official post of Botanist to the Geological Survey. The post has lapsed for all these years, and to-day, when the surveys of other civilised countries have their official palaeobotanists, it would be interesting to know why England, the first to originate the post and the premier coal-producing country in the world, should be minus so valuable a servant. Perhaps it may be a result of Hooker's early pessimism, for in his "Memoir" in 1848 he wrote: "Plants, whose tissues are so lax as to be convertible after death into a mass of such uniform structure as coal, evidently would not retain their characters well during fossilisation, under whatever favourable circumstances that operation may be conducted." We know to-day how much richer is our harvest than could then have been dreamed.

Concerning the extreme value and originality of Professor Williamson's work I need say little. He may justly be described as the father of botanical Palaeobotany. Our present *doyen*, Dr. Scott, has recently written of his life in the volume entitled "Makers of British Botany"; and then, too, fortunately we have Williamson's own autobiography. In 1840 he was a student at University College, under Professor Lindley; but he was an old man before he took up the science in which his researches opened up a new epoch. Like Hooker, Williamson was a man of exceptional calibre, eminent in other branches of learning. His study of the beautifully petrified plants in the now-famous "coal balls" gave results not only of palaeobotanical interest, but of vital importance for the science of modern botany. For instance, it was Williamson who, in face of the opposition of every living botanist of his day, propounded the fact that the lower vascular plants could develop secondary wood without, as the French school of palaeobotanists maintained, thereby qualifying for inclusion among the Angiosperms. Writing on Williamson's work on cambium, Solms Laubach said: "This is a general botanical result of the greatest importance and the widest bearing. In this conclusion Palaeontology has, for the first time, spoken the decisive word in a purely botanical question."

Williamson presented plant after plant from the lower coal measures of England, drawing the beautifully preserved structures with his own hand.

FIGURE 24.

The "Maiden Hair Tree" (Ginkgo [illegible]

[illegible] China and Japan, now grown [illegible]

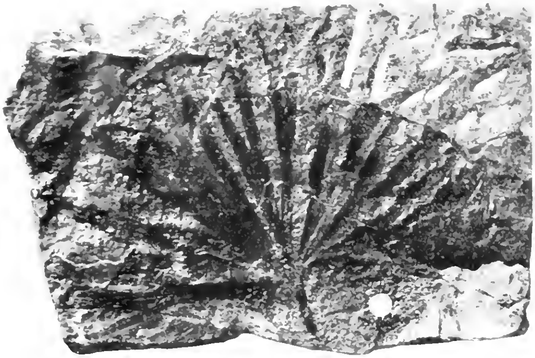


FIGURE 25. Leaf of *Baiera gracilis*, belonging to a genus allied to *Ginkgo*, from the Inferior Oolite of Scarborough.

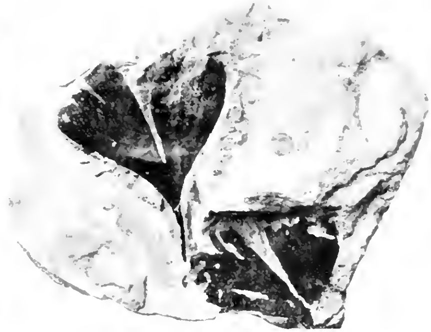
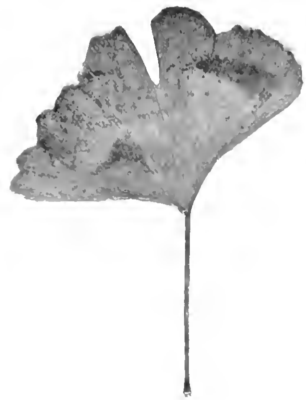


FIGURE 26. A variety of *Ginkgo digitata*, from the Inferior Oolite of Yorkshire.

FIGURES 27 and 28. Leaves of the living *Ginkgo biloba*, for comparison with the fossils.



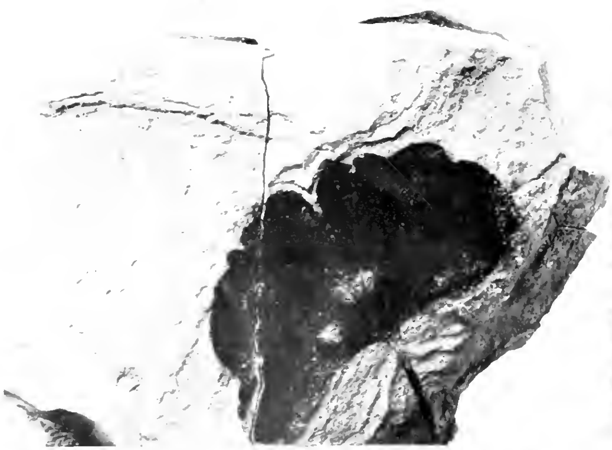


FIGURE 29. *Ginkgo* Leaf, from the Tertiary deposits of Mull.

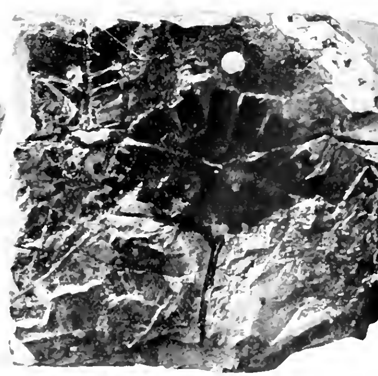


FIGURE 30. Another variety of *Ginkgo digitata*, from the Inferior Oolite of Yorkshire.

FOSSIL LEAVES OF GINKGOS.

How good both the drawings and the actual petrifactions were is evident on reference to any one of his famous series of monographs published by the Royal Society.

The anatomical structure of plants was also receiving attention at the hands of other brilliant men about the same time, chief among whom were Renault and Solms Laubach.

The more geological side of Palaeobotany was at that time growing rapidly as a result of the researches of Saporta, Heer, Ettingshausen, Lesquereux, and others. Heer in particular was doing work of world-wide fame in describing the plants from the more recent deposits of the Cretaceous and Tertiary of Switzerland and elsewhere, and in particular really stirring geologists to an acute interest in his discoveries of arctic floras, which indicated a once warmer climate for those now frozen zones. It is interesting to find how much opposition Heer had to encounter, and how steadfastly he continued in his intensely arduous and vexatious tasks; the fact that to-day many of his determinations can be questioned does not diminish his importance as a pioneer in a much neglected subject. It is interesting to see how Hooker himself, who was always inclined to scorn leaf determinations, yielded ultimately a tribute to Heer. Nevertheless, to some of Heer's work, and to many monographs published at the end of the nineteenth century, one might apply the following words, which, curiously enough, were published a hundred years before such work appeared. In 1784 Francis-Xavier Burtin said: "Malheureusement ceux qui découvrent un fossile s'empressent trop de le nommer, et le mot je *l'ignore* paroit avoir été de tout temps dur à prononcer. De la cette quantité de noms absurdes, dont la science oryctologique parvient si difficilement à se débarrasser."

Now, in the course of this rapid survey, we have come to modern times, and of living palaeobotanists I can scarcely speak. Long ago Sir Joseph Hooker said: "The Science [of Palaeobotany] has of late made sure and steady progress and developed really grand results"; and that is even more true to-day. Modern botany owes its chief advances in the branches of anatomy, morphology, and phylogeny to the study of fossil plants. To illustrate the magnitude of the recent contributions from fossils let me recall the coal-measure species *Lyginodendron*. The stems of this fossil described by Williamson showed *cycadean*-like wood, while the roots and foliage were fern-like. It was suspected by Williamson and Scott, Solms Laubach and others, that the fossil might belong to an intermediate group; but it was left to Professor Oliver and Dr. Scott to demonstrate that this plant, externally fern-like, bore seeds. From this discovery the new and vitally important group of Pteridosperms was founded, and in addition many data of great value for the morphological study of the evolution of seeds became available for the botanist.

Though the results of the anatomical study of plants are generally of much greater importance to the botanist than to the geologist, this is not always the case. For example, a certain specimen was discovered in the Cretaceous, and an enthusiastic Belgian restored a whole beast from this "bone"; and christened the creature *Aacheno-saurus*. But, alas for this monster! a palaeobotanist got hold of the one "bone" from which its superstructure had been raised, and, cutting a section of it, discovered that it was nothing more nor less than a piece of wood! Geologists have thus been saved by structural palaeobotany from one unnatural monster in their *Thiergarten*.

In my title I safeguard myself from the highly dangerous proceeding of speaking of the work of living colleagues. I have to consider only the past and the future of the palaeobotanist. But in order to show that my construction of the future is not entirely built on the dreams of my imagination, I must take some of the facts of the present for its foundation.

Palaeobotany has three sides; or, rather, the new science slowly reaching out from the shelter of its step-parents, Botany and Geology, is already a growth with three main branches, each of which bears fruits of value to three sections of the community.

First to botanists. I have spoken of some of the recent work of Palaeobotany as being indispensable to the science of modern botany. This is now recognised by every leading botanist, and Sir Joseph Hooker, in a letter to Dr. Scott in 1906, wrote of our "knowledge of botany as it advances by strides under a study of its fossil representatives." From the student of the fossils one learns not only of whole genera, and even families of extinct plants which help us to comprehend the relationships of existing types, but often the fossils exhibit complexities and novelties of character which not the most vivid imagination could have foreseen. For instance, what modern botanist, even in a delirious dream, could have conceived of a cone for the lower Carboniferous Pteridophytes so complex as *Cheirostrobus*, the demonstration of whose actual structure we owe to Dr. Scott?

The modern botanist's conceptions of morphology, his definitions even of an organ like the seed, have undergone profound modification through the introduction of ideas based on fossil facts.

But more than this: the botanist's *ultima Thule*, his Nirvana, is the attainment of a complete knowledge of the Natural System of plants; in other words, a complete knowledge of the lines of evolution of all existing species. From the study of modern plants we can obtain hints and make deductions, but *only from a knowledge of the fossils can we learn the actual facts of evolution.* Only

the palaeobotanist can demonstrate what forms of plant life actually did exist in all the succeeding epochs of the past.

As Jeffrey said recently in America: "There can be no doubt whatever that, without the background supplied by our increasing knowledge of fossil plants, the picture painted by the morphologist and embryologist of the evolution of plants is without depth and entirely without perspective." And Professor Coulter, the leading American botanist, said: "No plant phylogeny is adequate until it has included the historical record, which, of course, is the province of palaeobotany; and, furthermore, general conclusions based upon the study of the living flora alone are more apt to be false than true."

Connecting botanists with geologists are the plant geographers. How do they stand in relation to Palaeobotany? Let me illustrate by but one single well-known example, and in a few words tell the story of *Ginkgo*, the maiden-hair tree. This strange and beautiful tree, in the century just passed, was known to Europeans as occurring native only in the East of China and in Japan, and there always in temple grounds. Reports are current of finding it wild, but they have never been substantiated, and it is certain that in the living memory of man it is known *only* in cultivation. How are we to account for a tree with so restricted a *habitat*? Among modern plants it stands isolated; it has no near relatives; it is an enigma. But what has the palaeobotanist to say? Its well-marked, easily recognisable leaves are found impressed on the rocks, and not only in the Far East, but widely spread over the whole world. This unique tree, a few decades ago living only in the retirement of Oriental temple grounds, once flourished in innumerable groves and forests all over the world before the advent of man. Even in our own country and in the north of Scotland it grew as long ago as the Inferior Oolite, and in the past it was one of a numerous family, with relatives like but slightly differing from itself.

This isolated puzzle of to-day, extinct already in a wild state and only existing in semi-cultivation, is the remnant of an extremely ancient and prolific family.

But the romance of *Ginkgo* is not yet finished. Aided by man it has come out of its old retirement, and once planted will grow almost anywhere. We have a splendid tree at Kew; there is a still finer twin-tree in Vienna, and young trees are now flourishing in many cities in Europe and America. *Ginkgo* has come to its own again, and has to-day nearly as wide a geographic distribution as it had millions of years ago. Yet who but the palaeobotanist could have told us that it was no foreign intruder in England, but an ancient denizen of our country returning to its primaeval domains?

There are many similar cases in which the fossil history of a genus also affords evidence of departed land connections, gives indications of ancient climates, and in many other ways assists the palaeogeographer.

Asa Gray said: "Fossil plants are the thermometers of the ages by which climatic extremes and climate in general through long periods are best measured"; and Charles Darwin, in 1881, wrote to Hooker: "The extreme importance of the Arctic fossil plants is self-evident." At this time Hooker was preparing a public lecture, and Darwin added: "Take the opportunity of groaning over our ignorance of the lignite plants of Kerguelen Land or any Antarctic land. It might do good."

Through the palaeogeographer we come to the geologist. To what extent is he indebted to Palaeobotany? In this country it has been so arranged by Nature that there are no immense tracts of land composed of strata in which the only fossils are plants; had there been, possibly that Survey post held by Hooker in 1846 would not have lapsed. If our geologists think they can get along without palaeobotanists let us hear what the Americans have to say.

There are *twelve palaeontologists altogether in the United States Geological Survey, and of these four are palaeobotanists.* Take the record of one of these geological palaeobotanists, Dr. Knowlton. He says: "For the past five years I have annually studied and reported on from *five hundred to seven hundred collections,* each of which embraced from one to hundreds of individuals, and with them have helped the geologists to fix perhaps fifty horizons in a dozen states." A leading geologist in this country was once frank enough to tell me that he despised fossil botany, and would not have anything to do with it. Had he been set to survey the American Continent he would have found it necessary to eat his words. Across the Atlantic it is not only in the Upper Mesozoic and Tertiary among which Dr. Knowlton works that plant fossils may afford the only criteria of the age of deposits. In a district I know myself, Eastern Canada, there is an important deposit in the Carboniferous, which is destitute of any save plant fossils. For many years the most misleading and conflicting statements have been current about the age of these beds, some claiming them as Devonian, and some even as Silurian. Now that they have been studied in the light of modern Palaeobotany their Coal-Measure age is established beyond a doubt.

But geologists still sometimes say to palaeobotanists, as one said once to me: "No, no, you have let us down too often; look at the wrong determinations in Heer's work and Lesquereux's. No, we'll have nothing more to do with you."

Now in reply to such geologists I think I cannot improve on an illustration that appeared in *The Times* a year or two ago. We grant that deductions drawn from fossil plants have not always been perfectly reliable in the past. But this is because

the science was young; the work until the last decade or two was *all* in the nature of pioneer work; and even to-day much of it is still fundamentally pioneering. But because the pioneers cannot give one a detailed map of the whole country, is it sensible to reply we will have nothing more to do with anyone who goes into that country again? "It would have been just as sane in the old days to object to the Admiralty charts, and to stop all work on them, because they did not register *all* the rocks at sea, and some ships went down. The remedy for that was accurate study and correction of detail at the expense of enormous labour; and now the charts guide the ships quite safely. The remedy for the uncertainties regarding the rocks of the past is accurate study and correction of detail at the expense of enormous labour—labour greater than that of the making of Admiralty charts—for the rocks of to-day are in place, and, in the main, stay there, while the rocks of the past represent a series of world structures, continents, and seas fluctuating and merging in the long millions of years."

Now let us turn to the third branch of my science. This is the practical side, and deals specially with coal-mining because it happens that our main fuel is coal, and that coal is entirely composed of fossil plants. In their rough-and-ready way miners have "muddled along" without much help from palaeobotanists; but with a collaboration between the two, great advantages to both would accrue, and are to be looked for in the future. Palaeobotanical information to be of any value to the miner must be very detailed and accurate. It represents the ultimate refinement of the stratigraphical work I have just mentioned as being the province of geological Palaeobotany. Fine and accurate zoning by plants has already been successfully carried on, however, particularly in France, where Professor Zeiller of Paris, or M. Grand'Eury, is called in consultation before most mining operations of importance are undertaken. Let me illustrate this by an actual example of what happened on one occasion. In the Grand'Combe Valley there are many coal seams, and among them two in particular called the Sainte Barbe and the Grand'Combe. From a study of the fossil plants Professor Zeiller determined that the Sainte Barbe was the older of the two. As a result of this knowledge M. Zeiller advised the company to sink a shaft at a place called Richard, which would, he foresaw, take them into the Sainte Barbe seam. They sank the shaft for four hundred yards through barren beds, but did not finish it. Then M. Grand'Eury, studying the same horizons elsewhere, found that in his locality the same series cropped up with six hundred yards of barren strata between the two seams. He therefore pointed out that at Grand'Combe the miners should have continued the shaft Professor Zeiller advised a little further through the strata, and that they would find the coal where he had predicted. This the company did, and coal of the age foretold by Professor Zeiller was found where he had promised it. Thus Palaeobotany was vindicated.

Such achievements as Professor Zeiller's, however, are attained only as a result of detailed study based on a wide foundation. At his service M. Zeiller has magnificent collections filling many galleries in the Paris Museum, and the Department of Mines has published handsomely his extensive memoirs with their numerous magnificent plates.

Now this leads me back to my main pronouncement. *Palaeobotany is an intricate and independent science.*

Not even Professor Zeiller in Paris, nor the Survey in Washington, nor Professor Nathorst in Stockholm has all the equipment and the staff necessary. In Palaeobotany isolated individuals are struggling against the inchoate condition of the science, which is now so much vaster than is realised by more than a few people. To illustrate the enormous mass of detail with which a conscientious palaeobotanist has to cope turn to Dr. Jongmans' résumé of the publications for the year on the subject. It is 560 pages long, and on each page are on an average twenty-one entries. But this invaluable work has only been published for the last three years. For everything before that we have no centralisation of results, and the consequence is that everyone doing original work is hampered by being unable to find out what is previously known on the subject without himself wading through reams of print in a dozen languages, with the likelihood that he will miss many important things after all.

What do I think the palaeobotanist of the future will demand? That in at least *one* institution in each civilised country there shall be a recognition of his science and adequate accommodation for it. This institution would form the headquarters, the centralising bureau, for all the branches of work in which the individual palaeobotanists may be specialising, whether as geological palaeobotanists, botanical palaeobotanists, or practical miners. In this central department should be kept standardised collections of fossil plants, consisting, not only of handsome show-case or valuable type specimens, but also, so far as possible, of completely zoned collections of fossils of all ages, which should be referred to as the standards in any practical question of stratigraphy or mining. In this central department also should be available herbaria and immense series of sections of modern plants, with which to compare the fossils while working on the botanical elucidation of their structure. As things are to-day in any new branch of Palaeobotany the modern botanists do not provide exactly the kind of data wanted for comparison by the palaeobotanist. This is noticeably the case, for instance, in the study of early fossil Angiosperms. No modern botanist can show us the preparations of living Angiosperms that it is essential for us to see.

Then, too, in this central department of the science would be collected together, not only all

the literature on Palaeobotany, but this literature would all be indexed, analysed, and made available on several series of card catalogues. The work done by Dr. Jongmans for the last three years must be done for the last one hundred and fifty years, and put in the handiest form for reference, which is, of course, a card catalogue. Then there must be a complete card index of all the names ever given to fossil plants. Toward this great headway has been made in Washington, but their tens of thousands of slips are not yet complete, nor can European palaeobotanists go to Washington every time they need to use them. At present most palaeobotanists—all, indeed, save a few—tend to despise questions of nomenclature; but our science is in a very bad way owing to the immense numbers of names given on insufficient or wrong grounds. In a recent number of the American journal, *Science*, Mr. Casey, writing on zo logical nomenclature, says: "The subject is really serious, and should be given the attention of the ablest natural historians now, and without further delay, so that a secure foundation may be laid for future generations. Other work should be laid aside until this foundation is secure."

Without going so far as that, it is well to emphasise strongly the urgent necessity for palaeobotanists to reduce order from the chaos of their present nomenclature, and this can only be done by some centralising institution or committee who are sufficiently grounded in the science to realise the special needs of Palaeobotany.

Beyond all this it must not be forgotten that the collections of fossil plants at present made are trivial in comparison with those which will have to be made from all parts of the earth before we can completely unravel the histories of the ancient continents, solve questions of past climates, restore the details of innumerable extinct floras, and reconstruct the tree of plant evolution through the ages.

In spite of all the service rendered to science by Palaeobotany in the time of her humiliation and neglect, immense problems still lie unsolved. Darwin said in a letter to Hooker: "The rapid development, so far as we can judge, of all the higher plants within recent geological times is an abominable mystery." To-day it is an abominable mystery still, and it is my belief that an abominable mystery it will remain until Palaeobotany is recognised as an independent science and housed, endowed, and equipped so that she has the tools she needs for her work.

Nevertheless, until they are given spades or steam ploughs, palaeobotanists will continue to dig with their hands and to yield up gladly the fruits of their labours to any other science that needs them.

CORRESPONDENCE.

"THE ORIGIN OF LIFE."

To the Editors of "KNOWLEDGE."

SIRS,—My apologies are due both to Mr. Soddy and Mr. W. A. Douglas Rudge, for having, in a contribution to "KNOWLEDGE," attributed the work of the latter on Mr. Burke's so-called "radiobes" to the former. The original papers were not by me at the time of writing, and I can only attribute my error to some freak of the memory. Accounts of Mr. Rudge's experiments will be found in *Nature* (Vol. LXXII, page 631, and Vol. LXXIII, page 78) and were also presented to the Cambridge Philosophical Society.

As to the applicability of the expression "nine-day's wonder" to Mr. Burke's experiments: the question is hardly worth debating. In using it, I was thinking of the attitude of the general press and public. They seemed, at the time, to believe that Mr. Burke had solved the problem of life and accomplished spontaneous generation. Of course, no one believes that now. In fact, the experiments, I think, have little significance so far as this problem is concerned; and I merely referred to them in my article in the function of historian

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THE CHEMISTRY OF THE RADIO-ELEMENTS.

To the Editors of "KNOWLEDGE."

SIRS,—I notice that in the November number of "KNOWLEDGE" a note appears regarding my contribution to a discussion in the Chemistry Section of the British Association meeting at Birmingham, in which it is stated: "That of the . . . radio-active elements studied, all with the exception of Uranium – X, are chemically identical with common elements already known, such as lead, thallium, and thorium."

I trust that you will allow me to correct two errors that appear in this paragraph.

In the first place the exception to the general rule is that *Uranium* – X_2, not Uranium – X, has a chemical nature peculiar to itself alone. The body which was formerly called Uranium – X is now known to consist of two substances, Uranium – X_1 and Uranium – X_2. It is the first of these bodies that was known as Uranium – X, and for some considerable time now it has been recognised that that substance has chemical properties absolutely identical with those of thorium. The second substance, Uranium – X_2, was only discovered some eight months ago, and has chemical properties which no other substance possesses. It is somewhat analogous to tantalum, but can be separated from that element, as, *e.g.*, by volatilisation.

In the second place there are a number of other radio-elements which are not chemically identical with any common element, but the chief point to notice is that these elements have not chemical properties peculiar to themselves alone. For instance, mesothorium – 2 and actinium can be separated from any common element, but they cannot be separated from one another. There are one or two other examples of the same kind.

It is of interest to note that in examining the chemical nature of the radio-elements the quantity used was of the order of only a million millionth part of a gram, and yet their chemical properties are definitely known.

PHYSICAL DEPARTMENT, ALEXANDER FLECK.
THE UNIVERSITY, GLASGOW.

THE FACE OF THE SKY FOR FEBRUARY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 1.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Feb. 5	21 13.[illegible]	S 16.1	4 26.7	N 27.[illegible]	21 4[illegible]	S [illegible]	21 [illegible]8.6	S 17.7	6 27.0	N 27.1	4 [illegible]	N. [illegible]	7 [illegible]	N. [illegible]
„ 10	21 33.3	14.5	9 23.9	N 17.8	22 21.6	11.9	21 [illegible]3.7	15.9	6 25.[illegible]	27.0	4 [illegible]9.[illegible]	[illegible]	7 [illegible]	[illegible]
„ 15	21 52.9	12.9	13 50.8	S. 13.5	22 52.5	7.[illegible]	21 [illegible]	13.0	6 25.6	2[illegible]	4 [illegible]	[illegible]	7 [illegible]	[illegible]
„ 20	22 12.3	11.1	18 4[illegible]	S 27.[illegible]	23 17.7	[illegible].7	22 22.4	11.7	6 26.9	26.7	4 [illegible]	20.7	7 [illegible]	[illegible]
„ 25	22 31.[illegible]	S. 9.3	22 [illegible].4	S. 7.5	23 [illegible].3	S. [illegible].7	22 40.[illegible]	S. 9.4	6 29.4	N. [illegible]	4 4[illegible]	N. [illegible].7	7 [illegible]	N. [illegible]

TABLE 2.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	T
Greenwich Noon.	°	°	°	°	°	°	°	h. m.
Feb. 5	−13.8	−6.4	127.8	−3.9	−[illegible]	+1.2	[illegible]3	8 4[illegible] *e*
„ 10	15.7	6.6	61.9	+10.7	[illegible]	1.1	152.[illegible]	11 46 *e*
„ 15	17.4	6.9	350.1	+10.[illegible]	[illegible]	1.2	142.4	2 15 *m*
„ 20	19.1	7.1	290.5	−3.6	[illegible]	1.5	[illegible]	5 23 *m*
„ 25	−20.6	−7.2	224.4	−20.9	−22.[illegible]	+1.8	5[illegible].5	2 [illegible] *m*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

The asterisk indicates the day following that given in the date column.

THE SUN continues its Northward March with quickening speed. Its semi-diameter diminishes from 16′ 15″ to 16′ 10″. Sunrise changes from $7^h 44^m$ to $6^h 51^m$; sunset from $4^h 43^m$ to $5^h 35^m$. There will be an annular eclipse of the Sun on 24th, in the S. Pacific. Partial eclipse visible in New Zealand (part) several Pacific islands, Antarctic Continent, Patagonia (part).

MERCURY is an evening star. Semi-diameter 3″. Illumination nearly full on 1st, one fifth on 28th.

VENUS is too near the Sun for convenient observation. Disc practically full. Semi-diameter 5″. Superior conjunction, February 11th.

TABLE 3. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1914.			h. m.		h. m.	
Feb. 3	ε Arietis (double	4.6	5 2 *e*	63°	6 23 *e*	244°
„ 6	BAC 1848	5.6	8 5 *e*	145	8 51 *e*	210
„ 9	Wash. 603	6.9	4 57 *e*	145	—	—
„ 10	Wash. 630	6.7	5 38 *m*	120	—	—
„ 11	Regulus	1.3	5 55 *m*	132	6 45 *m*	285
„ 12	56 Leonis	6.1	2 28 *m*	156	3 26 *m*	278
„ 12	Wash. 759	6.8	—	—	9 46 *e*	335
„ 14	BD − 12° 3830	6.8	—	—	11 59 *e*	28
„ 18	τ Scorpii	2.9	6 16 *m*	83	7 30 *m*	300
„ 19	Wash. 1136	7.0	—	—	5 4 *m*	191
„ 27	Wash. 28	6.6	5 54 *e*	116	—	—

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

Attention is called to the occultation of Regulus on February 11th; both disappearance and reappearance should be observable, but the Moon will be low for the latter.

The Moon.—First Quarter $3^d\ 10^h\ 33^m\ m$; Full $10^d\ 5^h\ 35^m\ e$. Last Quarter $17^d\ 0^h\ 23^m\ m$. New $25^d\ 0^h\ 2^m\ m$. Perigee $12^d\ 2^h\ e$. Apogee $28^d\ 0^h\ m$, semi-diameter 16′ 32″, 14′ 44″ respectively. Maximum Librations, 5^d 7° S. 6^d 7° E. 18^d 7° N. 19^d 6° W. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 3.)

Mars is stationary on 13th. It will be seen that both hemispheres of Mars are observable, but the Northern one is best placed. The semi-diameter during February diminishes from 6½″ to 5″. The unilluminated lune is on the East; its width increases from ·4″ to ·5″. The Planet is in Gemini: 10° N. of γ.

Jupiter is invisible, having been in conjunction with the Sun on January 20th.

Saturn is still well placed for observation, having been in opposition on Dec. 7th. Polar semi-diameter 9″. P. is −4°·1; B −26°·4. Ring major axis 44″, minor 20″. The ring is approaching its maximum opening, and projects beyond the poles of the planet. It is interesting to measure the exact amount of overlap. The absolute maximum opening will occur on June 1st, but the Planet will then be too near the Sun to see.

East Elongations of Tethys (every fourth given), $1^d\ 4^h{\cdot}8e$, $9^d\ 6^h{\cdot}1m$, $16^d\ 7^h{\cdot}3e$, $24^d\ 8^h{\cdot}6m$; Dione (every third given), $4^d\ 10^h{\cdot}8m$, $12^d\ 3^h{\cdot}8e$, $20^d\ 9^h{\cdot}0e$; Rhea (every second given), $7^d\ 5^h{\cdot}9m$, $16^d\ 6^h{\cdot}8m$, $25^d\ 7^h{\cdot}7m$. For Titan and Iapetus E.W. mean East and West Elongations; I. Inferior (North) Conjunctions, S. Superior (South) ones. Titan, $2^d\ 2^h{\cdot}7m$ E., $6^d\ 2^h{\cdot}5m$ I., $9^d\ 11^h{\cdot}1e$ W., $13^d\ 10^h{\cdot}8e$ S., $18^d\ 1^h{\cdot}5m$ E., $22^d\ 1^h{\cdot}1m$ I., $25^d\ 10^h{\cdot}0e$ W; Iapetus, $13^d\ 1^h{\cdot}0e$ S.

Uranus is invisible, having been in conjunction with the Sun on January 28th.

Neptune was in opposition on January 17th. Semi-diameter 1″. Possessors of small telescopes may easily recognise it by its motion, if they make a sketch map of the stars in the region, and observe it night by night.

Meteor Showers (from Mr. Denning's List):—

Date.		Radiant. R.A.		Dec.	Remarks.
		°		°	
Feb.	5-10	75	+	41	Slow, bright.
,,	15	230	+	11	Swift, streaks.
,,	15	261	+	4	Swift, streaks.
,,	20	181	+	34	Swift, bright.
,,	20	263	+	30	Swift, streaks.

Double Stars and Clusters.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

Variable Stars.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable.

Table 4. Non-Algol Stars.

Star	Right Ascension.		Declination.	Magnitudes.	Period.	Date of Maximum.
	h.	m.	°		d.	
T Lyncis	8	17	−33 ·8	8·5 to 11·2	91·3	Mar. 25.
Z Cancri	8	17	+15 ·2	8·5 to 9·2	74	Jan. 19.
RV Hydrae	8	35	− 9 ·3	7·8 to 9·0	irregular	
S Hydrae	8	49	+ 3 ·4	7·5 to 12·5	256	Dec. 13.
X Cancri	8	50	+17 ·6	6·0 to 7·0	irregular	
W Cancri	9	5	+25 ·6	7·4 to 13·0	385	Jan. 10.
RS Cancri	9	5	+31 ·3	5·4 to 6·6	unknown	
Y Draconis	9	33	+78 ·2	8·2 to 11·5	336	Jan. 24.
R Leonis Min.	9	40	+34 ·9	6·2 to 13·0	371·5	Jan. 8
R Leonis	9	43	+11 ·8	5·0 to 10·2	312·8	Dec. 20.
Z Leonis	9	47	+27 ·3	7·9 to 9·6	59	Jan. 15.
Y Hydrae	9	47	−22 ·6	6·5 to 10·1	irregular	

Principal Minima of β Lyrae Feb. $7^d\ 3^h\ m$, $20^d\ 1^h\ m$. Period $12^d\ 21^h{\cdot}8$.

Algol minima Feb. $1^d\ 11^h\ 25^m e$, $4^d\ 8^h\ 14^m e$, $7^d\ 5^h\ 3^m e$, $22^d\ 1^h\ 8^m m$, $24^d\ 9^h\ 57^m e$, $27^d\ 6^h\ 46^m e$.

Mira Ceti will reach maximum in March.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

USE OF GALACTIC COÖRDINATES FOR STAR-PLACES.—Mr. R. T. A. Innes read a suggestive paper last July advocating the use of the Galaxy as the prime circle of reference for the stars, instead of the terrestrial Equator, which is continually shifting, necessitating an enormous amount of labour in bringing places up to the current date. If referred to a circle that was fixed among the stars, the only reduction to date would be that arising from proper motion, which is in most cases very small. The drawback of choosing the Galactic Circle is that the Galaxy is somewhat irregular and broken, and different estimates have been made of the great circle that represents it best. The choice must be to some extent arbitrary, and the starting-point for Galactic longitudes is also arbitrary. Mr. Innes suggests using the longitude of the Sun's apex, which he takes as R.A. 18^h, N. Dec. 30°. But obviously there is room for much difference of judgment, and it is exceedingly difficult to get the astronomers of all nations to agree on points of this kind. Further, it is likely that, for a long time to come, meridian instruments will be the chief means of obtaining the places of at least the brighter stars. Hence their R.A. and Dec. must still be found; and a tedious calculation, with seven-figure logarithms, would be required to reduce these to Galactic coördinates, whereas a four-figure calculation suffices for the present "star-corrections." For these and other reasons I do not expect the immediate adoption of Mr. Innes' proposals. The late Dr. Ristenpart's plan seems to me more practicable, viz., to publish all

star-places referred to one of a series of standard equinoxes twenty-five years apart (in this century 1900, 1925, 1950, 1975), the labour of "bringing up" stars would thus be minimised, though not entirely removed.

THE OCTOBER *JOURNAL OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC* contains an interesting paper by Professor Campbell on the astronomical congresses that were held in Germany last summer. I cull a few points. M. Donitch, of St. Petersburg, invites astronomers going to Russia for the eclipse of next August to communicate with him, so that they may be distributed as uniformly as possible along the line, and the risk of failure through cloud minimised. Attention is called to Dr. Abbot's conclusion that the output of solar energy increases at sunspot maximum, but that temperatures at the Earth's surface diminish then. These may be reconciled on the hypothesis that the cloudiness of our air increases with an increase of sunspots.

It is not long since Professor Joel Stebbins introduced the selenium photometer for recording star-variations. A further development has been made by Herr Rosenberg, of Tubingen, with a photo-electric cell. "When it was attached to a 5-inch refracting telescope he was able to determine the brightness of a fifth-magnitude star in two minutes within 0·002 magnitude. Stebbins commented in a generous spirit, saying that he himself took an hour to get the magnitude of a second-magnitude star within 0·01 magnitude." Professor Campbell considers the new instrument as important for stellar investigation as the spectroscope and photographic plate.

GREAT AMERICAN REFLECTORS.—It is good news that work on the 100-inch reflector and its mounting is advancing satisfactorily. It will need a dome one hundred feet in diameter and one hundred and five feet high. The telescope tube will be partly balanced by floating in mercury.

Another great reflector, of 72-inch aperture, has been ordered by the Canadian Astronomical Society, and will be placed on a mountain site. It will be possible to use it either as a Cassegrain or a Newtonian, or for observation or photography at the principal focus.

The 60-inch at Mount Wilson is being put to good use in stellar spectroscopy. It has been possible to obtain the spectra of nineteen stars in the Hercules cluster; of these seven are of the Sirian type, ten of the Procyon type, and two of solar type. Thus early spectral types predominate, which is in favour of the idea that the clusters are nurseries of stars at their earlier stages which have been formed from a single nebula, rather than that they have been collected together by gravitation after their formation as isolated stars. However, this must not be pressed too far, for the stars of late type are generally faint, and might be invisible at the great distance of the cluster.

Three faint stars in different parts of the sky are found to have high velocities of approach. Lalande 15290 (R.A. $7^h\ 48^m$) approaches us 242 km. per second, its total motion being 316 km. It is of solar type, magnitude 8·2. Lalande 5761 (R.A. $3^h\ 3^m$, magnitude 8·0) approaches at the rate of 144 km., and Lalande 28607 (R.A. $15^h\ 38^m$, magnitude 7·3) at 170 km. Both stars are of the Sirian type.

THE GEGENSCHEIN.—Professor Moulton and others suggested that the Gegenschein might be caused by the Earth gathering together a cluster of meteors at a distance of nine hundred thousand miles from it, on the side opposite the Sun. Professor H. D. Curtis took two photographs of the region with exposures of an hour each, in the hope that some meteors might be large enough to photograph; the result was negative. He considered that a meteor one hundred feet in diameter would have been registered; this is probably far above the usual size of meteors, though a few very large ones have been recorded. Hence the experiment in no way disproves the suggestion as to the cause of the phenomenon.

SIR DAVID GILL'S "HISTORY" OF THE CAPE OBSERVATORY. The work pays a well deserved tribute to Lacaille, who went out in 1750 under the auspices of the Paris Academy of Sciences, and laid the foundation of Southern astronomy. He made a catalogue of ten thousand stars, besides determining the parallax of the Moon and fixing 10″ as a rough approximation to that of the Sun. The amount of work that he accomplished in under two years was marvellous. The present establishment dates from 1821, when Fallows was sent out to found an observatory. The early conditions were anything but pleasant. The spot was known as "Snake Hill"; there were jackals and hippopotami in the neighbourhood, and on one occasion a leopard was found sitting on a shutter of the mural circle. Fallows died in 1831, after ten years of strenuous work under difficulties. His successor, Henderson, soon resigned his post, but not till he had done good work, including the finding of the parallax of alpha Centauri. His was really the first reliable stellar parallax, though it was not generally accepted till after the results of Struve and Bessel on Vega and 61 Cygni respectively. Henderson found 1″·16, which is only 0″·4 above the modern value, a very good approximation considering the instrument and method that he used.

Maclear, the next astronomer at the Cape, had the advantage of association with Sir J. Herschel, who spent four years (1834–1838) at Feldhausen, three miles distant. Maclear had a splendid record of work, which he continued till his retirement in 1870. Among other items may be mentioned observation of Halley's Comet when it ran south in 1835 and the commencement of the geodetic survey of South Africa, which was so energetically continued by Sir David Gill. An interesting personal reminiscence is the visit of Livingstone to the observatory before his famous explorations in Central Africa, to learn the best methods of obtaining geographical positions.

I shall resume these notes on the book in a future number.

OBITUARY.—Sir Robert Ball was probably the best known to the general public of all British astronomers. His books and lectures appealed to a very wide circle, from the ingenuity displayed in presenting facts in a quite untechnical way, with much grace of language and with many anecdotes and illustrations of a kind likely to come within the experience of his audience.

I have vivid recollections of a visit to Dunsink when a young schoolboy, and of Sir Robert's kindness in showing and explaining everything of interest. I saw much of him during the eclipse expedition to Norway in 1896. He contributed greatly to the public entertainment by his lectures and some humorous personifications of Irish characters—these were particularly acceptable when the ship ran aground at Tromso and the party was in low spirits, fearing considerable delay.

He will be missed and long remembered among a large circle of friends.

Another well-known astronomer is dead, Professor L. Weinek, of Prague. His chief study was the Moon, and he published a series of enlargements of the principal craters from the earlier photographs taken at the Lick Observatory.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

THE WILD WHEAT OF PALESTINE.—The discovery a few years ago of wild wheat in Palestine by Aaronsohn has attracted much attention, chiefly because of the possible practical importance of a hardy race of wheat. In Bulletin 274 of the United States Bureau of Plant Industry, O. F. Cook gives a full account of the culture of this wild wheat, which has been under observation for some time in America. The plant was first discovered on Mount Hermon, and later in the Jordan Valley, and is especially abundant on limestone. Its flowers show variable arrangements for pollination, being not only adapted for cross-pollination by

extruding its stamens, but in some cases being protogynous (stigma matures in advance of stamens) or protandrous (stamens mature before stigma), though sometimes it is adapted for self-pollination like the domesticated races of wheat. The great individual variation shown by this wild wheat is attributed to the great freedom in its adaptations for pollination, and it is further concluded that the self-pollination of the domesticated races is not a primitive condition, but that the adaptations for cross-pollination have been lost, and that as a result there has been a decline in vigour, fertility, and disease resistance. While there is apparently no reason for doubting that this Palestine plant is a genuine wild wheat, it is not certain that it is the prototype of our domesticated races; it is, in fact, suggested that it be named as a distinct species, *Triticum hermonis*. Whether or not it is the prototype of the domesticated wheat does not, of course, affect its practical value; for it is a hardy plant in the sense of being able to live under a wide range of natural conditions, and it suggests the possibility of obtaining from it races of wheat adapted to the arid regions of the world, and also of breeding its power of resisting rust disease into the domesticated races.

SOIL FUNGI.—The mere fact of the abundance of different species of fungi which appear above the surface of the soil in the form of spore-producing bodies indicates the existence in the soil of the thread-like vegetative organs of an enormous number of fungi. Indeed, rich soil like that of woods is permeated with fungus threads, and is practically the "spawn" of these fungi. Besides those fungi which live in the soil and send up large conspicuous spore-bodies—mushrooms, toadstools, and so on—there are numerous forms with small and inconspicuous fructifications, including the common moulds of various kinds. A closer investigation of the matter shows that many species of fungi live habitually in the soil, carrying out their life-history there, either wholly or in part, and that a considerable number of these have only been found, so far, in the soil. Several recent workers have isolated soil fungi by cultivating samples of soil in various nutrient media, and their results show that not only is the fungus flora of the soil an extraordinarily rich one, but that many of the species have a remarkably wide range, and are apparently world-wide in distribution. Identical species have been found in England, Holland, and in different parts of North America.

One of the latest papers on this subject is by Goddard (*Bot. Gazette*, October, 1913), who finds that these forms are to a large extent uniform in different soils, and that, unlike the bacteria, they are also uniformly distributed at different depths down to about fourteen centimetres. Moreover, it would appear that tillage and manuring produce but little change in the number or kind of these fungi, though further investigation is required on this point. One may infer in a general way that these soil fungi probably play an important part in connection with soil fertility, since they convert organic matter into other forms of which some are suitable for the nutrition of higher plants. Some of the soil fungi enter into a symbiotic association with the roots of plants, and help to supply these with food in a suitable form for absorption: these are the well-known "mycorrhiza" fungi. There is a certain amount of evidence that the mycorrhiza fungi are, like some bacteria, capable of fixing free atmospheric nitrogen; that is, converting the free nitrogen into nitrates which are absorbed by roots. Goddard has carefully investigated this matter in the case of a number of soil fungi, but his results were in every case negative: none of the forms studied showed any power of assimilating free nitrogen. The fungi showed a certain amount of growth in nitrogen-free media, but in such cases the nitrogen content was found by analysis to fall within the limit of error of the method employed, and the growth was starved and shrivelled as if deficient in a necessary element. The question is a rather difficult one to decide, as it involves very delicate methods of analysis, and the capability of fungi for fixing free nitrogen has been alternately denied and affirmed by different investigators.

ACTION OF FORMALDEHYDE ON LIVING PLANTS.—Many kinds of evidence point to formaldehyde (CH_2O) being the first, or one of the first, organic compounds produced in photosynthesis—that complex and still very imperfectly understood chain of processes by which green plants build up organic substance out of carbon dioxide and water. Miss S. M. Baker has recently (*Ann. Bot.*, 1913) made quantitative experiments on the effects of formaldehyde on green plants, in which seeds were grown in an atmosphere containing known quantities of formaldehyde, some of the cultures being grown in darkness and some in light. A comparison of the change in dry weight with that of control cultures, with and without carbon dioxide, showed that formaldehyde could be used for the synthesis of food materials to some extent in light. The gain in dry weight was about half the loss due to respiration; and an increase in the percentage of formaldehyde in the air did not produce a corresponding increase in dry weight after a certain concentration. An excess of formaldehyde was, of course, poisonous. In the dark formaldehyde was not assimilated, but appeared to stimulate respiration: its toxic effect was more marked than in light. Acetic aldehyde could not be taken up by the plants; hence the assimilation of formaldehyde in light is not due merely to the aldehyde group.

These results are capable of two interpretations: (1) Formaldehyde is a step in respiration, and is converted by the plant into carbon dioxide before it can be assimilated; or (2) it is the first step in photosynthesis, and its further elaboration by the plant requires light energy. To decide between these two possibilities quantitative experiments were made, in which the change in dry weight of the cultures could be directly compared with the carbon dioxide evolved during respiration. It was found that this ratio agreed closely with that calculated for the complete oxidation of a carbohydrate. When formaldehyde was passed over the cultures in the dark there was no change in the quantitative relations between the loss in dry weight of the cultures and the carbon dioxide of respiration. Hence formaldehyde was not converted into carbon dioxide by the plants, nor used as a source of food material in the dark. Probably, therefore, formaldehyde may function as a stage in photosynthesis, but the production from it of sugars and other food materials requires light energy.

USE OF LIQUID AIR IN PLANT PHYSIOLOGY.—In a series of interesting papers Dixon and Atkins (*Sci. Proc. Royal Dublin Soc.*, 1913) have shown that liquid air may be applied with great advantage in the extraction of plant juices. Many conflicting determinations have been made of the osmotic strength of the sap in plants by investigators who had obtained the sap by pressure from the plant organs—leaves and so on. The sap obtained by pressure has been regarded as a fairly average sample of the sap of the organ pressed; but it was found that when leaves were exposed to chloroform vapour and then pressed the sap was obtained with much greater ease, and its freezing-point was much lower than that of sap from untreated leaves. The greater concentration of the sap from chloroformed leaves is evidently due to the fact that the chloroform makes the protoplasmic membrane of the cell more permeable, and thus allows the sap to escape more readily under pressure; but it was found that prolonged treatment was necessary to make all the cells permeable, and so allow the sap obtained to be a fair sample of that of the uninjured leaf and such prolonged exposure has the objection that, during the process, enzymes in the cells may considerably alter the nature of the dissolved substances and so lead to a change in the concentration and constitution of the sap. Much better results were obtained by exposing the leaves and other parts to the extremely low temperature of liquid air, which made the membranes permeable, and at the same

time arrested changes taking place in the tissues. On being immersed in liquid air the tissues immediately become frozen hard, and then they are at once transferred to, and enclosed in, a stoppered vessel to prevent the condensation of moisture on them from the air owing to their extreme cold; such condensation would, of course, cause dilution of the sap. When the tissues have assumed the temperature of the surroundings they are pressed in the usual way, and comparatively small pressure is required to obtain the sap, which flows easily from them without requiring the disruption of the cells, while at the same time the sap is much freer from the débris of broken cells than that from an untreated leaf. Sap thus obtained always gives a greater lowering of freezing-point, and usually a higher electrical conductivity, than that from the same tissues untreated. The estimates obtained in previous work on osmotic pressure of cell-sap must be raised, and in some cases considerably, as the result of the application of this new method.

The fact that exposure to intense cold makes the protoplasm permeable, so that the sap can be obtained by pressure in an unaltered condition, suggested the possibility that similar exposure of the yeast-cell would render its protoplasm permeable, and that the zymase and other enzymes in the cell would be free to escape. Experiment has confirmed this surmise. The liquid-air method for extracting yeast ferments is not only extremely efficient, but also very rapid: it requires only about half an hour to prepare the zymase-containing liquid from the solid yeast, and the time for changes taking place in the enzyme is reduced to a minimum. The authors are now investigating the possibility of applying the method to the extraction of endo-cellular substances from bacteria. Another use of the method is suggested by the authors. It is generally held that sterilised foodstuffs are less assimilable owing to the destruction of the enzymes of the tissues. The experiments here noted have shown that by means of liquid air sap-containing enzymes may be extracted from cells without serious alteration. The sap, frozen immediately after extraction, might be evaporated to dryness as ice under reduced pressure, and the resulting powder stored and added to the food as desired to replace the enzymes lost by sterilisation.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

BEESWAX OF THE VIKING PERIOD.—Some eight years ago a ship of the early Viking period was discovered at Oseberg, near Tönsberg, in Norway. It was completely buried in the earth, and when disinterred was found to belong to the grave of a Viking queen, who died about A.D. 800. Horses, carriages, and sledges were also discovered in the grave, together with all kinds of household furniture and utensils and personal ornaments, the whole forming a picture of the state of northern civilisation ten centuries ago. Among the other articles found were two dark rectangular masses, which proved to be wax that had apparently been used for the waxing of sewing thread.

This wax has recently been chemically examined by Dr. J. Sebelien, who has published the results of his analyses in the *Zeit. angewandte Chem.* 1913, XXVI, 689). It melted at 63° C., and had a specific gravity of 0·963 at 15° C., and thus in both respects agreed with the values given by normal beeswax. Its chemical constants were also well within the limits of those given by genuine beeswax, although in some respects they were a little high as compared with the values of modern Scandinavian beeswax. For example, the ratio between the acid value and the ester value of modern Norwegian beeswax ranges from 4·0 to 4·3, whereas the ratio in the case of the Oseberg wax was 4·74. The iodine value (*i.e.*, the percentage of iodine absorbed) was 6·0, and in this respect the wax agreed more nearly with ordinary beeswax than with humble bees' wax, which has an iodine value of about 16.

The microscopic examination of the vegetable débris in the wax proved particularly interesting. The wax was dissolved in warm xylene, and the solution whirled in a centrifugal machine to separate the insoluble matter. The deposit consisted of a few pollen grains, including one which appeared to have been derived from *V[illegible]*, since cuticle hairs, similar to those occurring on the stamina of that plant, were also present. Other pollen grains were identified as belonging to cruciferous plants, while another appeared to have been derived from a member of the *Caryophyllaceæ*. In addition to pollen the deposit contained fragments of wood charcoal, hairs from the bodies or legs of bees, the epidermis of a barley corn, granules of barley starch, a single oat-starch granule, and particles of conifer wood.

NEW SALTS OF PHOSPHORUS.—Among the compounds of phosphorus and hydrogen is a solid body, P H, which has been found by MM. Bossuet and Hackspill to act as an acid and form salts with metals (*Comptes Rendus*, 1913, CLVII, 720). If the rubidium salt, P Rb, be exposed to gaseous ammonia it is unaffected, but when liquid ammonia is used a yellow solution is obtained, and this, on evaporation at − 18° C., leaves crystals of a double salt with the composition, P Rb.5NH. By treating solutions of this compound in liquid ammonia with a solution of a heavy metal in the same solvent double decomposition takes place, with the precipitation of the corresponding insoluble compound.

For example, lead has in this way been made to combine directly with phosphorus to form a lead phosphide with the composition P Pb. This compound is an amorphous black substance, which will ignite spontaneously in the air. It is slowly attacked by water and by dilute sulphuric and hydrochloric acids, which decompose it into solid hydrogen phosphide and lead sulphate or chloride. Similar compounds may be obtained with silver, copper, strontium, barium, and so on, the precipitates being yellow in the case of metals of the alkaline earths, brown with silver, and black with other metals. The difficulty of separating these phosphides in a pure state is increased by the fact that they have to be washed with liquid ammonia in closed flasks, and that they readily undergo oxidation.

THE FORMS OF ARSENIC.—Several crystalline forms of arsenic have been described, but doubts have been expressed as to whether these are all allotropic modifications of the element. Dr. Kohlschütter and two collaborators have recently studied the question, and have come to the conclusion that the only definite allotropic modifications of arsenic are black or metallic arsenic and yellow arsenic (*Annalen*, 1913, CCCC, 268). This opinion is based upon the great difference in the specific gravity of the two modifications. When black arsenic (specific gravity 4·7) is distilled at 450° C., in a vacuum in a dark room, with only a red light, and the vapours condensed by means of liquid air, the yellow crystalline modification with a specific gravity of 1·97 is obtained. By subliming this yellow form, or by crystallising it from carbon bisulphide, a grey arsenic, of coarser character, is obtained which has the same specific gravity (4·7) as metallic arsenic, and must be regarded as being merely in a different ultra-microscopic state of division. Again, when solutions of arsenic compounds are treated with certain reducing agents a very fine crystalline brown arsenic is obtained. This has the same specific gravity as the metallic or grey forms of arsenic, and apparently differs from them only in the state of its crystalline division.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

THE FIXATION OF NITROGEN.—Calcium carbide is formed by heating together lime and carbon, and when calcium carbide is maintained at a temperature of 1650° F. for about twenty-four hours, in an atmosphere of nitrogen, the carbide becomes converted into calcium cyanamide. The resulting product is known as nitrolim, and contains

twenty per cent. of nitrogen, twelve per cent. of free carbon, sixty per cent. of lime (free and chemically combined), and eight per cent. of inert substances. The wonderful commercial development of these processes is described in an article in *The Times* Engineering Supplement for October 15th. Electric furnaces, having a capacity of sixteen to eighteen tons a day, are charged automatically and almost continuously with powdered anthracite and burnt lime, the temperature being maintained at 5720° F. The calcium carbide formed is tapped in the molten state at intervals of forty-five minutes, allowed to solidify, and crushed to sizes suitable for packing or for further treatment. The annual output of carbide at Odda, on the west coast of Norway, is now eighty thousand tons. The electric power for the furnaces is, of course, obtained by the utilisation of waterfalls. Most of the carbide formed is converted into cyanamide. Entirely new works are now in process of construction at Aura capable of making two hundred thousand tons of cyanamide annually. To obtain the requisite nitrogen, air is liquefied by the Linde process, and the nitrogen and oxygen are then separated by fractional distillation. No less than one hundred tons of atmospheric air are liquefied daily at the Odda factory, seventy-seven tons of nitrogen being obtained. Calcium cyanamide, as such, is being increasingly used throughout the world as a fertiliser, and its utilisation for the production of ammonia on the commercial scale has recently been developed. As from ammonia and nitric acid the road is clear to countless products required by modern peoples, the manufacture of calcium cyanamide must further increase, and already the production of nearly two million tons a year is contemplated.

EXPOSURE TESTS OF COPPER, COMMERCIAL ALUMINIUM, AND DURALUMIN.—In Section G of the British Association Mr. Ernest Wilson communicates the continued effect of exposure in London on the electrical resistance of wires of copper, aluminium, and duralumin. Since 1911 the percentage increase of electrical resistance, taken on the value in 1911 at 15° C., is 2·0 for high-conductivity copper, 4·4 for commercial aluminium, and 8·2 for duralumin. The specimens have a length of seventy feet and a diameter of 0·126 inch. Duralumin is a copper-manganese-magnesium alloy of high tensile strength, and exposure has apparently made it more brittle.

COPPER STEEL.—The view has been widely held that the presence of even small amounts of copper in steel has a prejudicial effect, and red-shortness has been attributed to copper in cases where the harmful element was undoubtedly sulphur. As copper occurs chiefly as sulphide when present in iron ores, the presence of copper in steel made from such ores might also necessarily mean the presence of sulphur. It has been frequently found, on the other hand, that in cases of specimens of steel showing unusual strength, hardness, and resistance to corrosion these improved qualities were due to copper present accidentally. In an investigation designed to ascertain the effect of adding pure copper to steel of good quality, Professor C. Howell Clevenger and Mr. Bhupendranath Ray succeeded in preparing a series of sound ingots containing up to 4·5 per cent. of copper. (*Trans. Amer. Inst. Min. Eng.*, 1913, 2437, through *J. Soc. Chem. Ind.*, 1913, 1071.) Structurally the copper, which alloyed with the ferrite, was found to produce a more even distribution of the fibrous cementite, giving rise to a finer structure. All the ingots forged well, except the one richest in copper, and strength and hardness both increased with increasing copper content. The results obtained indicate, in fact, that the addition of small amounts of pure copper to the extent, say, of one to two per cent. has only a beneficial effect on the quality of the steel so treated.

THE INTERCRYSTALLINE COHESION OF METALS.—Considerable interest has been aroused by the "amorphous cement" theory put forward by Dr. W. Rosenhain, with others, in several papers, one of which, by Dr. Rosenhain and Mr. D. Ewen, was read before the August meeting of the Institute of Metals. The theory is that the crystals of which metals are built up are held or "cemented" together by an extremely thin layer of amorphous, or non-crystalline, material chemically identical with the substance of the metal, or alloy, in question, but in a widely different physical state. The amorphous condition of this intercrystalline layer is regarded as being identical with, or at least closely analogous to, the condition of a very greatly undercooled liquid, which has remained in that condition in the minute interstices which occur where adjacent crystals meet one another in various orientations. The curve connecting temperature and strength of such a material would naturally be continuous, while that of crystallising material would show a discontinuity at the crystallising point, and the two curves would intersect at a point corresponding to some temperature below the crystallising temperature. This indicates that at the temperature corresponding to the point of intersection the cement and the crystals have the same strength, but that at other temperatures one or other would be more considerably affected under strain. If the intersection temperature and the solidifying temperature of a metal or alloy are wide apart, then at temperatures just below the solidifying point one should find the cement considerably weaker than the crystals, and under fracture, at least for slow straining, the fracture should not only be of the intercrystalline type, but should occur without any material deformation of the crystals themselves, even if the crystals are those of extremely ductile metals.

To test the truth of this reasoning the authors made experiments with the metals lead, tin, aluminium, and bismuth, using metals of a high degree of purity. Bars of the metals were cast, and while suspended in a vertical position were heated to a temperature about 50° C. below the melting-point of the metal in question. This temperature was held for one hour, and then a small weight was attached to the lower end in order to produce a slight and constant load. The weight chosen gave a stress of about seventy-two pounds per square inch. The temperature of the bars was then slowly raised until fracture took place. The results were in all cases completely as anticipated, fracture of the heated bars taking place without appreciable elongation or reduction of area, and with the jagged edges in keeping with its intercrystalline character.

It is pointed out that the general fact that all metals become extremely weak and brittle at temperatures near their melting-points is thus explainable by the amorphous cement theory.

The authors discuss the question as to whether the intercrystalline material may not consist of films of eutectic alloys formed with traces of impurities in the metals, but consider the evidence to be much more favourable to the theory they advance.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

TRAVEL IN THE CAUCASUS.—In the *National Geographic Magazine* for October Mr. George Kennan has an interesting and well-illustrated article on a journey which he made over the eastern Caucasus in company with a magnate of the country, to whose train he managed to add himself. In such difficult and unknown country, where guides could not be got, he was fortunate to secure such an escort. These mountain tracts have been from distant times a refuge for the exile, the wanderer, and the outcast of a score of different nations, and are inhabited by an assortment of the descendants of peoples ranging from wandering Jews to derelict Crusaders, who preserve, as a dress for gala days, the armour and trappings of their chivalrous forebears; and the types remain almost as distinct and characteristic as their ancestors. There has been no blending into any sort of nationality, and there

are no common characters beyond those of the precarious life in the inhospitable mountains, where every man's hand is against his neighbour's, impressed on one and all. The scenery of this "Russian Switzerland" is of the wildest and grandest, and the mountain barrier is passable at two places only. The descent on the southern side is interesting. On the summit of the pass the wind that meets one climbing over from the east chills to the core. One breakfasts amid Arctic snows, lunches in the cool air of a temperate region, and in the evening dines in the open fanned by the soft air of an Italian summer." Most interesting are the dwellings of the natives, built recklessly, tier on tier, in the manner of the Pueblo Indians, on an inaccessible mountain-steep, reached by a dizzy track with eternal zigzags. On the topmost eminence stands the watch-tower to testify to the troublous nature of bygone times. But past these relics of mediaevalism runs the telegraph wire, and gradually civilisation is penetrating the formerly impregnable and lawless stronghold of one of the most primitive populations of Europe.

THE ALLEGHANY DIVIDE.—The study of the fauna of rivers, from the point of view of the history of drainage systems, is particularly fascinating, and Mr. A. E. Ortmann, who has done a considerable amount of faunistic work in the region, has in the *Proceedings of the American Philosophical Society*, No. 210, an interesting study of the relations of the Alleghany system from this point of view. He has worked mainly on evidence obtained from the Najades, but remarks that Gastropods, Crayfishes, and Fishes should provide almost equally interesting and valuable testimony. His main conclusions may be mentioned. The Alleghany system forms an old and effective faunistic barrier, whose efficiency may have been reduced as the country assumed the aspect of a peneplane, but which was emphasised by post-Cretaceous elevation of the country and consequent rejuvenation of the drainage. West of the divide is a uniform and distinct fauna which exhibits remnants of an older one; but the unity of the Upper Ohio fauna has been acquired since Glacial times, and it demonstrates the connection of certain rivers assigned to other basins with the Ohio system. The Atlantic fauna of the eastern slope of the Alleghany is distinct from, but a derivative of, the western fauna, and includes two distinct elements, a northern and a southern, the latter containing some ancient forms, the former not being very old but pre-Glacial. Along the Atlantic slope there is a north and south dispersal line, available for both land and water forms, which probably lies along the coastal plain, where the rivers are at base-level; and there has doubtless been dispersion of forms by stream-capture also.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

VESICULAR SEDIMENTS AND SEDIMENTARY INFILLINGS IN LAVAS.—The curious infillings and intercalations of sediment in the Old Red Sandstone volcanic rocks of Scotland, first noticed and described by Sir Archibald Geikie, are described in detail by Dr. A. Jowett in a paper on "The Volcanic Rocks of the Forfarshire Coast" (*Quarterly Journal of the Geological Society*, October, 1913). The same subject has also been dealt with recently by Mr. John Smith in his book, "The Semi-precious Stones of Carrick"; and by the author in a paper on the Old Red Sandstone Volcanic Rocks of Carrick, Ayrshire, now in the press. The sediments in question are red and green mudstones and fine-grained, compact, mica-spangled red and green sandstones. They frequently enclose lumps of slaggy volcanic material, and are themselves occasionally vesicular. They are found as small inconstant lenticles wedged in between the flows, and also filling cracks and cavities in the solid lava. The fine layers of sediment have frequently been broken and distorted. Dr. Jowett ascribes the singular occurrence of vesicular sediments, as well as the buckling and distortion of the layers, to the flow of hot lava over unconsolidated material containing much water. The water in the rock was boiled, but the steam generated was prevented from escaping owing to the outlets being sealed by the molten rock. Hence spheroidal cavities were produced, which later were usually filled with calcite and chlorite, forming amygdales. The movement of the molten magma over the moist sediment crumpled the superficial layers, and gave rise to the crumpling and breaking of the bedding planes.

Dr. Jowett concludes that the lavas were outpoured into water in which fine sediments were accumulating, but does not say whether the water was that of the sea or of inland lakes.

Mr. John Smith believes that the similar Old Red Sandstone lavas of the Carrick Hills, Ayrshire, were poured out on land, and that the intercalated sediments were accumulated in temporary pools on the surfaces of the lava-flows. He has found what he believes to be trailing marks, tracks, and other traces of land animals in the sediments, which form conclusive evidence of terrestrial conditions.

The present writer supports Mr. John Smith's view as to the accumulation of the lavas and sediments on land surfaces, and believes the sediments to represent the fine muddy wash from the lava-flows into temporary pools. This material was supplemented by wind-carried grains, especially mica-flakes, gathered from the arid surface of the Old Red Sandstone continent. A conglomerate indicating terrestrial deposition was found, similar to those described by Dr. Jowett from Forfarshire. In the Carrick coast section certain dark, highly polished knobs of lava-rock stand out, having resisted marine erosion better than the surrounding rock. Under the microscope it is found that this rock is thoroughly permeated with red iron oxide (haematite). These areas are believed to represent the sites of temporary pools into which ferriferous solutions drained from the surrounding rocks.

THE RATE OF EROSION AND THE AGE OF THE EARTH.—In a recently published paper H. S. Shelton makes it clear that the present stage of the controversy as to the age of the Earth is marked by the revolt of the geologists against the physicists ("Some Aspects of Geological Time," *Science Progress*, October, 1913). He goes so far as to say that no single one of the methods which up to a few years ago were regarded as valid is of any value whatever. Recent criticism and discovery have shattered the theories of Lord Kelvin, and the collateral methods of Joly and Sollas have also been subjected to destructive criticism. The trend of present-day opinion is to demand a vastly greater duration of geological time than even geologists had hitherto thought probable. These views are supported by several considerations. For example, the data concerning the rate of erosion of the surface of the Earth, on which is based an estimate of the age of the Earth, are extremely variable. Rivers provide the chief index of the rate of erosion in the amount of material they carry with them, and which they must have obtained from their drainage areas. The rivers of which reliable measurements have been made are the Mississippi, the Ganges, the Hoang-Ho, the Rhone, the Danube, and the Po. It is a remarkable fact that all the rivers with a large discharge of sediment, such as the Ganges, the Irrawaddy, the Hoang-Ho, the Rhone, the Danube, and the Po, are situated in densely populated and highly cultivated areas. The high rate of erosion indicated by these rivers may be regarded as due to the exceptionally great denudation to which alluvial and cultivated land is liable. Rivers which have a low rate of discharge of sediment are the Uruguay, Rio Grande, and the Nile. With the exception of the Nile, these are situated in districts of sparse and low cultivation. The Nile is exceptional owing to the absence of rainfall in the lower part of its basin and the discharge of its sediment over the rainless areas during its annual overflow. These facts suggest that the normal rate of discharge of sediment from a river is low, and that high rates are abnormal and due to

the influence of man as a geological agent. Hence estimates of geological time should be based on a rate of denudation calculated from rivers whose basins are as yet undisturbed, or little disturbed, by man. In general this will result in a large increase of the estimate of geological time arrived at by this method.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

TORRENTIAL RAINFALL AT MONTELL, TEXAS. —In the United States *Monthly Weather Review* for June it is reported that on the 28th a Gulf disturbance of moderate intensity moved inland near Corpus Christi, where a wind velocity of fifty miles per hour from the south-east was recorded. The storm apparently broke up over the upper Nueces watershed, after giving copious rains in that section. The centre of heaviest precipitation was at Montell, Uvalde County, where from 2.30 p.m., June 28th, to 9 a.m., June 29th, the fall amounted to 20·60 inches, being equivalent to an average rate of 1·11 inches per hour for eighteen and a half consecutive hours. Uvalde, in the same county, and less than thirty miles south-east of Montell, reported a rainfall of 8·50 inches from 1 p.m., June 28th, to 6 a.m., June 29th. These rains caused considerable damage in that section, flooding the lowlands, washing away houses and stock, and interrupting traffic and communication by telegraph and telephone for several days. One person was drowned in the vicinity of Montell.

The rainfall at Montell is the heaviest twenty-four-hours precipitation record in Texas, and the next heaviest is eighteen inches, occurring at Fort Clark on June 14th and 15th, 1899. It is remarkable that these torrential rains should have occurred in the same section of the State and in corresponding months.

DAILY TEMPERATURE CHANGE AT GREAT HEIGHTS.—When observations by means of registering balloons were first started in England in 1907, it was soon found that the effect of solar radiation upon the thermograph was a matter that must be reckoned with. To avoid the trouble balloons were mostly sent up a little before sunset, and this custom was continued till the meeting of the International Committee for Scientific Aeronautics at Monaco, in the spring of 1909. At that meeting the time of 7 a.m. was fixed for the international ascents, that being the time for which the morning weather chart is drawn. Since then ascents have been made in England at the specified time, viz., 7 a.m., on the twenty-three specified days per annum. But other ascents have also been made on the international days, and on days of special meteorological interest, such as the occurrence of thunder, or of a very high or very low barometer; and such ascents are mostly made in the evening. Some two hundred good observations have been made in the British Isles, reaching to about sixteen kilometres, concentrated into two nearly equal groups, one with its centre two hours after sunrise and the other about a quarter of an hour after sunset. Mr. W. H. Dines, F.R.S., has carefully discussed these records, and he gave the results in a paper which he read at the November meeting of the Royal Meteorological Society. He found that above two kilometres and up to the isothermal column the daily range of temperature, if it exists at all, does not exceed 2° C., and that the maximum is in the afternoon or evening.

AWARD OF THE SYMONS GOLD MEDAL.—The Council of the Royal Meteorological Society have awarded the Symons Gold Medal for 1914 to Mr. W. H. Dines, F.R.S., in recognition of the distinguished work which he has done in connection with meteorological science. The medal, which is awarded biennially, was founded in 1901 in memory of the late Mr. G. J. Symons, F.R.S., the originator of the British Rainfall Organisation. The former recipients of the medal have been: Dr. Alexander Buchan, F.R.S., in 1902; Dr. Julius Hann, of Vienna, in 1904; Lieut.-General Sir Richard Strachey, F.R.S., in 1906; M. L. Teisserenc de Bort, of Paris, in 1908; Dr. W. N. Shaw, F.R.S., in 1910; and Professor Cleveland Abbe, of Washington, in 1912.

The medal will be presented at the annual meeting of the Royal Meteorological Society on January 21st.

GREAT RAINSTORM AT DONCASTER.—On September 17th, 1913, during a period of disturbed weather, a remarkably heavy and local fall of rain occurred in the vicinity of Doncaster. Mr. R. C. Mossman and Mr. C. Salter, of the British Rainfall Organisation, have investigated the matter, and have found that the storm lasted fourteen hours, from about 7 a.m. to 9 p.m., and in that time more than four inches of rain fell at six observing stations, of which four had more than five inches. The greatest amount measured was 6·43 inches at the Doncaster Sewage Pumping Station, while 5·67 inches fell in Avenue Road and 5·50 inches at Brodsworth and Wyndthorpe. The small area embraced by the heavy rain is shown by the circumstance that more than four inches of rain fell over only sixty-one square miles, and more than five inches over only twenty-seven square miles, while more than half an inch fell over 2,336 square miles. Over the latter area it is calculated that 47,330 million gallons of water were precipitated. No adequate explanation of the storm has been offered, but the phenomenon affords an opportunity for special investigation.

MICROSCOPY.

By F.R.M.S.

GROUND-GLASS LABELS.—The late Dr. Dallinger advocated the use of ground-glass labels for all specimens (Carpenter, Edition VIII, page 524). He used a special block of wood, a lead butt, and emery powder; when the writing was completed it was covered with a drop of balsam and a coverglass. For many purposes the method may be simplified. The edge of any table may be used as a support protected with a piece of brown paper. Two slides may be prepared at a time, by using the second to do the grinding. Put a drop of water on the end of Slide A, which is held close to the edge of the table, not overlapping it. Add to the water about a cubic millimetre of fine emery powder (not knife-powder), and stir up gently and evenly with the flat end of Slide B. When the powder is seen to be evenly distributed on the part of the slide to be converted into a label one applies a little more friction, combined with pressure, with the thumb of the other hand. The powder is then washed off in a stream of running water. The whole process is quite brief and easy, if care be taken to use only a little powder and to distribute it well before rubbing hard. One can then write on the prepared suface with an ordinary lead pencil, the marks of which may be removed by friction, but not by any ordinary handling, nor by the reägents used to stain the slide. If necessary, they could be afterwards removed and the necessary inscription written in Indian ink, which could be covered in balsam after drying; but for many purposes the pencil marks make a satisfactory label. This plan is especially useful when films of blood are to be taken from a number of patients: being marked at the time of taking, they cannot be afterwards mixed up. An ordinary label, or a grease pencil, would not serve the purpose, as the film must be stained in a neutral methyl-alcohol solution.

E. W. B.

NOTES ON BLOOD FILMS.—In making the film the usual mistake is to take too large a drop of blood. A drop two millimetres in diameter is large enough for normal blood; in cases of anaemia make it a very little larger. This drop of blood being near one end of a clean slide, bring up to it the rounded surface of a glass rod one inch long, which is held lightly at the sides of the slide by two fingers. Let the blood flow along the side of the rod distal to that part of the slide on which the film is to be. Then, without delay, steadily draw the rod backwards along the slide, not rolling it, nor brushing the blood along in front of

it, but merely drawing out the column into which the drop has been converted. Practically no pressure is required. The film, when complete, should be quite uniform, without lines—of only the faintest orange colour—exhibiting diffraction colours when viewed at an angle by transmitted light. It is, of course, necessary to wash the little glass rod after use. Staining is usually carried out by means of the double salt of eosin and methylene blue in methyl-alcohol solution. Various distinguished persons have introduced modifications of the process, the most interesting being that of Dr. S. G. Scott, who has found that the best staining effects are obtained by mixtures of various eosinates. It is advisable, for instance, to have some of the thionin salt present, in addition to the eosinate of methylene blue. I have myself obtained good results from a number of different compounds, especially when combined as Dr. Scott recommends ("Focia Haematologica," Band XIII, 1911, page 302). I find it is best to keep the solution in plain-stoppered bottles of the first quality, which have been carefully washed and neutralised. Pour about four drops of the stain into a clean watch-glass and pour this straight on the slide in one sweep, so as to cover all the parts to be stained simultaneously. Now put into the watch-glass the same quantity of distilled water. When the undiluted stain has acted for half a minute (thirty seconds) pour it back into the watch-glass and mix it with the water. Then quickly return the mixture to the slide, and allow it to act for three minutes—not longer. Finally wash away the excess of stain with distilled water until the corpuscles are seen under the microscope to be duly differentiated. If the stain is allowed to act for longer times than these (according to the usual directions) the eosin will tend to extract the methylene blue; and unless you wash for a long time the red cells will be lilac in tone, while, if washing be prolonged, you may lose the blue stain more or less completely. Some writers speak of the methyl alcohol as having a fixative effect on the film. If one tests the fixation by trying other stains, it is found to be of an extremely mild order. I prefer to say that the methyl alcohol has a slight hardening effect, but does not harden to such an extent as to prevent the methylene blue and its compound acting as an *intra vitam* stain, *i.e.*, exercising an independent and selective fixing action. The stain is also soluble in ethyl alcohol; but in this medium the solution is much more dilute, so that about twenty-four hours are needed to stain the film. Evidently the staining process is in this case delayed by the hardening action of the ethyl alcohol, which ultimately inhibits it altogether, so that even after a day's exposure one does not get a well-coloured film. The little clay tripods which are used to support inverted incandescent mantles form most excellent supports, on which the slide may be placed for the operation of staining, so as to avoid that extra staining of surrounding objects which is at once inartistic and unnecessary. In spite of the durability of these mantles disused clay tripods are not rare.

Undoubtedly blood films are best examined by the aid of an immersion lens, and it is all but essential that it should be an oil immersion. When the film has thoroughly dried the colour will be fairly permanent under a layer of oil, but quite the reverse under balsam and glass. As one must rapidly examine a great many cells, it would be an advantage to use an objective of lower power than the $\frac{1}{12}$", and for this special purpose the $\frac{1}{8}$", formerly made by Reichert, is exceedingly convenient; indeed, it may be doubted whether for general purposes an eighth (3 mm.) is not preferable to a twelfth (2 mm.), if the numerical aperture be the same. At the same time, if no abnormalities or doubtful forms be present, a differential count can be quite well made with a B (half-inch) objective and a high-power orthoscopic ocular. Strain of the eyes is then the chief disadvantage. E. W. B.

DARK-GROUND ILLUMINATION FOR THE HAEMOCYTOMETER.—It is a frequent complaint that the lines in ruled counting chambers are difficult to see. This is probably often due to the illumination being bad, either because in the circumstances proper light cannot be obtained, or because the usual form of substage condenser will not focus through so thick a slip. The back of the Zeiss Abbe condenser will do this admirably, and with a suitable-sized stop it will give excellent dark-ground illumination to an objective of medium aperture, such as the Zeiss B; and this, with a medium or high ocular, gives all the magnification that can be required for such a purpose. With such an arrangement the lines are distinct enough. But, in any case, the lines are more obvious with a half-inch and a high ocular than with a sixth and a low ocular. As it is only a question of seeing the lines the worse definition does not matter; it is still good.

At Professor Sahli's suggestion, Messrs. Leitz have recently brought out a form of haemocytometer, in which the reticulum is in the eyepiece. (A similar reticulum to fit micrometer oculars has been made for some time past by Messrs. Winkel: it has a different arrangement for identifying the individual squares: evaluation must in this case be performed by the user, but this is not difficult.) In this arrangement there can be no difficulty in seeing the lines.

It may occasionally be desirable to ensure special accuracy in the count by roughly sketching each corpuscle visible in the field. The size of the field in squares is then found, and the corpuscles counted on the sketch. If due regard is paid to its proper adjustment the Abbe camera permits this process to be carried through quite quickly.

E. W. B.

QUEKETT MICROSCOPICAL CLUB.—At the meeting held on November 25th, 1913, the President, Professor A. Dendy, F.R.S., dealt with "A Red Water Phenomenon due to *Euglena*." The water of a pond near Manchester was observed to be of a brilliant red colour. Examination showed this to be due to *Euglena*, which formed quite a thick scum of the red colour. The red colour was due to the replacement of the chlorophyll by haematochrome. Mr. Jas. Burton (Honorary Secretary) read a paper on "The Disc-like Termination of the Flagellum of some *Euglenae*." Some two years ago a member (Mr. N. Ellis) had observed that *Euglena*, after prolonged confinement in the life-slide, threw off the flagellum, which then, in the majority of cases, appeared to be terminated by a small disc or bulb. Reference was made to similar observations recorded in *Science Gossip*, 1879. Mr. Burton had come to the conclusion that the disc is purely an optical effect due to the "kinking," or coiling upon itself, of the thin thread of protoplasm. Mr. Burton also described a method of marking a given object on a mounted slide for future reference. In the case of objects large enough to be recognised under a hand-lens a dot of water-colour is placed over the object with a fine camel-hair or sable brush. The slide is placed on a turntable, and the dot carefully centred. A small ring of some dark cement is run round the dot, and, when dry, the dot cleaned off. In higher-power work find and centre the object in the field with a suitable power. Then substitute a water-immersion one-tenth; put on the front lens as small a drop of water as possible, and focus. When the object is recognised and centred raise the tube rather sharply, leaving a dot of water on the slide. Charge this with colour—carmine was suggested—and, when dry, ring as before and clean off the colour. An oil-immersion used with water may be employed, or any close-working objective available if a water-immersion be not in the outfit.

Dr. Spitta said that, after having centred an object, he replaced the objective with a dummy carrying on its lower end a rubber letter O. This was inked and carefully lowered on to the slide.

Mr. J. Grundy read a paper, by Mr. E. M. Nelson, F.R.M.S., on "The Measurement of the Initial Magnifying Powers of Objectives." The apparatus required is a stage micrometer, and a screw micrometer with positive eyepiece. With a tube of a length as described below the interval of two $\frac{1}{1000}$ inch divisions of the stage micrometer is read

on the drum of the eyepiece. This reading will be the initial magnifying power of the objective. The formula for the determination of tube-length is $15\sqrt{\frac{1}{p}} + \cdot 335$, where p is the nominal initial power. All powers of a quarter of an inch and less, and all apochromats, require a nine-inch tube. This is measured from the nosepiece to the web of the micrometer.

PHOTOGRAPHY.

By EDGAR SENIOR.

FURTHER TEST FOR THE PRESENCE OF "HYPO."—In addition to the methods given in our Notes for the December issue of "KNOWLEDGE" that in which a solution of mercuric chloride is employed is strongly to be recommended, as it is capable of detecting the presence of a very small quantity of "hypo" in the washing water from negatives or prints. The test solution is prepared according to the following formula :—

Mercuric chloride	300	grains
Ammonium chloride	109·5	,,
Water	5	ounces
Strong hydrochloric acid ...	40	minims

The ammonium chloride is for the purpose of forming the double chloride $HgCl_2 . (NH_4Cl)_2$, which affords a more delicate test, and the hydrochloric acid prevents any precipitate of carbonate of mercury when hard water containing carbonates is employed, but in no way interferes with the reäction due to "hypo." Having prepared the above solution its usefulness may be shown in the following manner : Take an ordinary test tube and fill it three-parts with water, and then add a single drop of the ordinary "hypo" fixing solution, and well shake. The contents of the tube are then to be emptied out and fresh water introduced, when, on the addition of one or two drops of the mercury solution, a bluish opalescence will be produced, caused by the small quantity of "hypo" which still remains. As the amount of "hypo" will be very small the test must be carried out with nicety, using a clear solution and a glass vessel that is perfectly clean. It is also advisable to have a second tube filled with clean water for comparison. If, in testing the washing water of prints, the washing is carried to such a point that "hypo" cannot be detected in it, heating the water in which some strips of the prints are soaking will, in nearly all cases, cause "hypo" again to show itself to the test. This, of course, shows that the salt is never completely removed by washing; but the less of it that remains the longer the prints are likely to last.

"HYPO" ELIMINATORS.—On account of the prolonged washing that is necessary very completely to remove "hypo" from prints and negatives various methods have been recommended to be applied after a short washing in order to decompose the remaining "hypo" into an inert substance, and thus gain a saving in time. The first "hypo" eliminator suggested appears to have been alum, which was recommended as far back as 1855 by Sir W. J. Newton ; and, while this substance does reäct with "hypo," the products appear to be undesirable, although it is sometimes employed after a prolonged washing for removing the remaining trace of "hypo" previous to intensification with silver in the case of negatives. Now thiosulphates ("hypo"), like sulphites, are readily oxidised ; thus free chlorine, sodium hypochlorite, and ferric chloride completely oxidise them to sulphates, even when cold, and advantage has been taken of this by using sodium hypochlorite as a "hypo" eliminator, the late Mr. F. W. Hart having been the first to employ it for this purpose in 1866. The method "which was applied to paper prints" consisted of treating them with a very dilute solution of the salt until the prints no longer discharged the blue colour of iodide of starch, which is bleached if "hypo" is present. Afterwards the prints were washed in a very weak solution of ammonia to decompose any silver chloride formed during the reäction. The method is effective owing to the "hypo" being completely oxidised to sulphate, as shown by the equation

$$Na_2 S_2 O_3 + 4Na ClO + H_2 O = 2Na HSO_4 + 4Na Cl.$$

Of the various methods that have been introduced for the elimination of "hypo" this one appears to be the most satisfactory, owing to the complete oxidation of the "hypo" ; and, although sulphates are, generally speaking, inert, they are liable to undergo decomposition in the presence of moisture and organic matter such as paper.

About the year 1866 Dr. Angus Smith and Mr. J. Spiller suggested the use of hydrogen peroxide for the purpose of eliminating "hypo." This body, however, produces a mixture of sulphate and trithionate of sodium as follows :—

$$2Na_2 S_2 O_3 + 4H_2 O_2 = 4H_2 O + Na_2 SO_4 + Na_2 S_3 O_6$$

and the latter decomposes into other substances. After the expiration of some days the solution will give a precipitate with the mercuric chloride test, showing that the whole has not been converted to sulphate ; and on this account a solution of hydrogen peroxide is not to be recommended for the purpose.

In 1872 the late Dr. Vogel recommended employing tincture of iodine, this being added to water until a straw-coloured solution was produced, when the prints were immersed in repeated baths of the same until the paper assumed a bluish tint, indicating excess of iodine ; and, although the method appears to increase the permanency of the prints, it is open to the same objection as the last one in giving a precipitate with the mercury test solution. Moreover, the action of iodine upon "hypo" is to produce a tetrathionate

$$2Na_2 S_2 O_3 + 2I = Na_2 S_4 O_6 + 2Na I$$

and while both of these salts are soluble in water they are less so than "hypo," while the tetrathionate is itself unstable.

Another "hypo" eliminator, under the name of "anthion," was introduced by Messrs. Schering in 1895. This substance, which is potassium persulphate, was to be employed at a strength of about seventy-seven grains, dissolved in thirty-five ounces of water ; and the plate, after having been washed for five minutes, was to be immersed in this solution for five minutes, again washed for five minutes, when the treatment was repeated once more and the plate again washed. As the persulphates dissolve metallic silver, the action cannot be prolonged without risk of damage to the negatives ; and so far as tests with the mercury solution are concerned the action appears to be no more effective than the treatment with iodine or peroxide of hydrogen, as a precipitate is formed even after an excess of the persulphate has acted upon "hypo" for several days.

PHYSICS.

By ALFRED C. EGERTON, B.Sc.

MOLECULAR WEIGHT OF ACTINIUM EMANATION. — The radio-active elements — radium, thorium, and actinium—give rise to radio-active gases, or "emanations," when their atoms disintegrate. They disintegrate with the expulsion of an α-particle—an electrically charged helium atom ; as the helium atom weighs 4 (compared to the atom of hydrogen), it is evident the atomic weight of the atom of the emanation should be a number less by 4 or a multiple of 4 than the atom of the parent element. Radium has an atomic weight about 226, so that the atomic weight of niton (the emanation) should be 222. This number was about the mean of the determinations which Ramsay and Gray succeeded in carrying out by their delicate method of weighing gases, which has already been described in these columns.

The case of actinium is interesting. There is doubt

what is its position in the series of radio-active elements. If it could be obtained in sufficient purity and quantity its atomic weight might be determined, and this would act as a means of telling whether it was a direct ancestor of the radium atom coming after the uranium products, or whether it was the progeny of one of those products on a side issue; or, again, it might be the member of a radio-active series which had no relation to the Uranium-radium series—a different family of radio-active substances. Now the atomic weight has not yet been established; but if the weight of the emanation could be found, that of the actinium atom would be known. Actinium emanation has a period of only a few seconds, and the quantity of it which can be obtained is very small; consequently a direct determination of its density by weight is practically out of the question. The density of gases can, however, be determined by their diffusion, the rate of diffusion being inversely proportional to the square root of the density. The method which has been devised by Messrs. Marsden and Wood is on these lines.

Two vessels of known volume are separated from each other by a small hole (one square mm. area): one of the vessels contains a small branch tube containing actinium. The actinium will give rise to emanation, which will effuse into the empty chamber; the number of molecules passing through the hole depends on its area, on the mean molecular path of the molecule, and on their number on either side of the hole. A steady state would be reached when the number disintegrating in the second vessel equalled the number entering through the hole. The ratios of the number of molecules passing through the hole could be determined by measuring the activity of the deposit on the walls of the vessel after a certain time (about three hours). The mean molecular path could then be calculated, and hence the weight of the molecule, because $\Omega = 14546\sqrt{\frac{\theta}{M}}$, where θ is the temperature.

In this way the above-mentioned authors have obtained the number 232 as a preliminary measurement of the molecular weight of actinium emanation. Actinium gives rise to two products of the same atomic weight, radio-actinium and actinium X; and this disintegrates into the emanation, so that the atomic weight of actinium should be $232 + 8 = 240$. This would place it outside the uranium family of radio-active elements. Some have considered that actinium is the product of Uranium Y; others that it is a branch product from Radium C; but the above result would make these ideas improbable. It will be interesting to hear if the value is confirmed.

INTERMITTENT VISION.—The wheels of a motor-car are often seen so that the spokes appear stationary for a moment, although the wheels are rapidly rotating. This has been traced by Mr. Mallock, F.R.S., to a slight shock received by the observer, such as is given by a motion of the jaw or the jerk of a stride or a blink of the eye. The same effect can be observed if a top is covered by a diagram representing the spokes of a wheel and is rotated; when the observer's head is tapped the spokes appear stationary for the moment.

SPECIFIC GRAVITY LEVER.—Dr. Butler Savory has introduced an instrument for measuring the specific gravities of all liquids from the lightest to the heaviest, with only a small amount of the liquid. It has also the advantage of portability. The instrument consists of a vessel, at one end of a lever, which is balanced level by means of a sliding weight. The instrument is set by filling the vessel with water and adjusting the slides until the spirit-level on the beam shows that the latter is level. Another liquid being substituted for water, the adjustment is made by means of another smaller slide which moves along a graduated beam. The instrument appears eminently practical, and should be very useful, as the determinations would be very quick and easy to carry out.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

SPELLING DOGS. Everyone has heard during the last two years of the "thinking horses" of Elberfeld, which stamp out answers to arithmetical questions written on the board, and in many cases give the correct answer the very first time. When $\sqrt{15876} - \sqrt{12769}$ was written on the board one of them stamped out thirteen before any person present, so far as is known, had been able to work the sum. That they understand what an arithmetical process is remains unproved; that they compute in some fashion of their own like "calculating boys" is possible; that they simply stamp out an answer somehow communicated to them is also possible; but, telepathy apart, no suggestion of the mechanism of signalling has been offered that fits the facts. Another chapter in animal education has been opened by the careful training of a dog at Mannheim, which has learned to spell and to recognise drawings of common things. The spelling lessons were on "Morse" lines, as used with the Elberfeld horses. Each letter is denoted by two figures; thus *e* by 11, which involves two stamps—one with the right paw and one with the left—and *n* by 12, which involves two stamps with the right paw and one with the left. Now the other day Professor H. E. Ziegler, a well-known zoölogist and student of instinct, called on the dog and drew a mouse on a piece of paper, whereupon the dog spelled out "Maus." The Professor then drew a flower, and the dog spelled "Blüml," which is a dialect form of the German for flower, *Blume*. What happened the third time, when Professor Ziegler drew an elephant, may be suppressed just at present.

REMARKABLE RESPIRATION.—Professor O. Fuhrmann describes the respiration of an interesting Caecilian genus, *Typhlonectes*, from Colombia. In Caecilians the left lung is usually rudimentary, but in this type both lungs are long and very narrow. Both are supported by rings of cartilage, as if they were tracheae. The long trachea gives off ventrally in front of the heart a curious spindle-shaped body, which turns out to be an accessory third lung. Moreover, the animal breathes through its skin. Finally, it probably has buccal respiration. The creatures often swim energetically in pursuit of fishes, and their elongated, very narrow lungs seem to require assistance, and they have got it!

HOW CUTTLEFISHES DEAL WITH CRABS AND BIVALVES.—It used to be supposed that cuttlefishes suffocated crabs with their suckers and then tore them open with their beaks. But the method is more subtle. In 1895 Krause showed that the secretion of the posterior salivary glands of the octopus was very toxic, and it was supposed that the octopus gave a poisonous bite. But Piéron has recently shown that the octopus at least does not bite the crab until after death. The paralysing secretion is probably wafted into the crab with the respiratory current.

Similarly, in regard to bivalves it was thought that the cuttlefish forced the valves asunder by fixing suckers to each valve and then pulling in opposite directions. But Piéron has shown with cockles, mussels, scallops, and the like that the toxic juice first paralyses the adductor muscles. In the case of the cockle the octopus breaks some of the teeth on the posterior margin of the shell, so that the salivary juice may get in more readily. After paralysis has set in force is employed, but it does not require much. The secretion from the stomach of the starfish has apparently the same paralysing action on bivalves.

TROPISM OF HORNED BEE.—A tropism is an obligatory reaction of an organism to some persistent external stimulus, the organism seeking to adjust itself

symmetrically in reference to the stimulus. A. Popovici-Baznosanu has experimented with the horned bee (*Osmia bicornis*), which often develops inside reeds. The cocoons made by the larvae have the conical pointed end upwards. If larvae that have eaten all their provisions be placed in boxes they make cocoons at right angles to the floor; if the reed be inverted they make their cocoons pointed upwards as usual; if a larva is put in a sloping box the cocoon is still made vertically in relation to the earth; if the larvae are placed in a horizontal glass tube the cocoons are all disposed vertically. There is a strong tropism to dispose the cocoon symmetrically in relation to gravity.

COLORATION OF A SEA-URCHIN.—Dr. J. Stuart Thomson has done an interesting piece of work in analysing the possible interpretations of the variable coloration of *Echinus angulosus*, a sea-urchin common on South African coasts and elsewhere. Many colours occur on different specimens—purple, red, green, grey, intermediate between purple and grey, intermediate between green and purple, pink, lilac, and so on. It is shown that the coloration has nothing to do with sex, and that it cannot be grouped under the headings "protective" resemblance, "aggressive" coloration, "warning" indication, except by excessive exercise of imagination and ingenuity. The meaning of the coloration of *E. angulosus* is to be sought for in the internal physiological processes (probably respiratory or excretory) of the animals themselves. The variable tegumentary colouring of *E. angulosus* is probably due to by-products or waste-products produced during the metabolic processes. The author's view, that it is not necessary to hold that every characteristic of an animal is adaptive, seems to us very sound sense.

CHINESE FLEA-TRAP.—Dr. Edward Hindle describes a flea-trap much used in Sze-Chwan. It consists of two pieces of bamboo, one inside the other. The outer is about a foot in length and two and a half inches in diameter; it is longitudinally fenestrated. The inner bamboo is of equal length, but only about an inch in diameter. It is kept in position by means of a short wooden plug. The inner bamboo is coated with birdlime or the like; the outer bamboo is protective. The trap can be placed under bedclothes, among rugs, and so forth; any fleas that go through get caught on the birdlime. Dr. Hindle suggests that the trap might be of great value in connection with plague epidemics.

POISON OF HORNETS.—Professor E. Bettarelli and Dr. A. Tedeschi have made an experimental study of the poison of hornets. It behaves on the whole like that of bees and wasps, and has also distinct resemblances to snake poison. It tends to dissolve blood-corpuscles and to produce convulsions. The investigators have not been able to decide as yet whether the hornet's poison produces an antitoxin or not.

SOLAR DISTURBANCES DURING NOVEMBER, 1913.

By FRANK C. DENNETT.

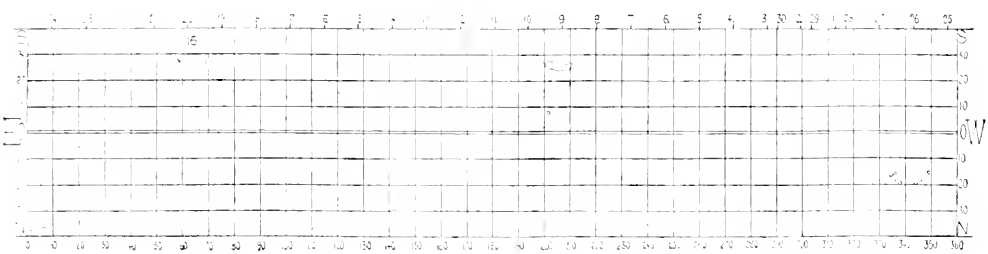
As compared with October, November proved a very quiet month to the solar observer. The Sun was under observation every day, but on three only (24th to 26th) were dark spots visible. Faculae, or bright markings, were recorded on twelve days (3rd to 6th, 11th, 14th, 15th, 20th to 23rd, and 27th); but on all other days the disc appeared free from disturbance. The longitude of the central meridian at noon on November 1st was 312° 30′.

No. 16.—Two larger spots, with pores, in the midst of bright faculae were first seen on the 24th approaching the south-western limb, the leader being much the smaller, and the following spot at first appeared double. The umbrae of both appeared more conspicuous next day, whilst the eastern spot was still visible near the south-western limb on the 26th. The eastern spot was at least eight thousand miles across, and the length of the group appears to have been over ninety thousand miles. As will be seen, it was situated in high southern latitude. On the 24th the area of the group was found by the spectroscope to be strewn with flocculi of hydrogen, which caused deflections of the C-line on the red side, the same line also showing brilliant reversals.

On the 3rd, 4th, and 5th a fine group of faculae—marking the position of spot group No. 15—was approaching the north-western limb. On the two later days dark hydrogen flocculi widened the C-line, and the helium D_3 was visible as a dark line. Traces of the same group were also seen within the north-eastern limb on November 20th to 23rd. On the 6th a tiny bright granule was visible within about 15° of the North Pole, near the eastern limb. On the 11th a tiny bright facula was situated a few degrees from the South Pole well to the east of the central meridian. On the 14th an elliptical faculic ring, somewhat pale, was seen in longitude 200° to 211°, approaching the south-western limb, some of the rear portion being observed on the 15th, when some small faculic knots were seen about the same longitude only 8° south of the Equator. Faculae were also visible within the south-eastern limb on November 27th.

Our chart is constructed from the combined observations of Messrs. John McHarg A. A. Buss, C. Frooms, and F. C. Dennett.

DAY OF NOVEMBER, 1913.



REVIEWS.

GEOGRAPHY.

Preliminary Geography.—By F. G. Hodgkinson, B.A. (Lond.), F.R.G.S. 225 pages. 33 maps. 6¾-in. × 4½-in.

(The University Tutorial Press. Price 1/6.)

Within certain limits the value of a geographical textbook for "young learners of eleven to fourteen years of age" varies inversely as the number of names mentioned: this book fairly well satisfies this test, the names are clearly set out with the reasons for their importance, and there is a careful "physical" introduction (sixty-five pages out of two hundred and thirteen). With the help afforded by its index it should be possible for a student to work out for himself answers to questions, under the guidance of a good teacher (no questions are included); but the items of information cover such a wide field that a boy could hardly be expected to digest the whole as it stands. It should be useful as a reference-book on which questions can be set.

J. C. C.

HISTOLOGY.

Physiological Histology of Man and Mammalian Animals, Illustrated by Microscopic Preparations, with Explanatory Text and Drawings.—By Dr. Fr. Sigmund. English edition by C. Lovatt Evans.

Part II.	*Organs of Movement.*	19 pages.	10 plates.
Part III.	*The Central Nervous System.*	22 pages.	10 plates.
Part IV.	*Reproductive Organs.*	14 pages.	10 plates.
Part V.	*Respiratory Organs.*	17 pages.	6 plates.
Part VI.	*The Eye and its Accessories*	17 pages.	8 plates.

Each part is accompanied by ten microscopic slides. 10-in. × 7-in.

(Carl Zeiss (London). Price 10/- each part.)

We have already alluded to the appearance of the English edition of Dr. Sigmund's "Physiological Histology" the first number of which appeared early last year. The letter-press is written in a clear and simple manner; the plates are exceedingly well done, though the introduction of descriptions in three languages—French, German, and English—necessitates the use of smaller type than would otherwise have been adopted. The slides are up to the standard of those which were circulated with the first part, and some of the preparations are quite out of the way—the one, for instance, showing the nerve endings in muscle. In this the preparation is made from the muscle of the grass-snake. The nerve endings are stained by the gold-chloride method, which is a most difficult one. Only a few of the end plates are picked out by the stain, but they are shown in all the slides which are distributed.

W. M. W.

HYGIENE.

A Manual of School Hygiene.—By Edward W. Hope, M.D., D.Sc., Edgar A. Browne, F.R.C.S.E., and C. S. Sherrington, M.D., F.R.S. 311 pages. 7½-in. × 5-in.

(The Cambridge University Press. Price 4/6.)

This excellent little book may be said to contain everything that a teacher ought to know from the hygiene point of view. It can be roughly divided into three sections. The first deals with the school as a whole—its building and sanitation, and the food, clothing, and general hygiene of its scholars, as well as the infectious diseases to which they are liable. In the second the individual child is considered, and the last six chapters, giving a brief outline of human physiology, may be looked upon as a third section. While the book as a whole is admirable, we regard the second section as being particularly valuable. Never before have we seen such useful and practical advice on the hygiene of the ear, nose, throat, and eye written so simply that no teacher can fail to understand it. The chapter on over-pressure in this section is also admirable. The book is illustrated by diagrams and plans of ideal schools and is provided with a fairly complete index. It should be in the hands of every school teacher.

S. H.

Handbook of Physiology.—By W. D. Halliburton, M.D., LL.D., F.R.C.P., F.R.S. 923 pages. 577 diagrams, some of which are coloured, and 3 coloured plates. 8½-in. × 6-in.

(John Murray. Price 15/- net.)

Still another edition of this admirable text-book has appeared. We recognise it as the twenty-fourth edition of Kirke's Physiology, which still maintains its reputation as the best general text-book of moderate dimensions on the subject. In the present edition a good deal of new work on the heart, respiration, the vitamines and the secretion of the saliva is included. Many of the chapters have also been re-written, notably the last on Reproduction and Development.

The book is well arranged, and it is easy to find any special subject in which one is interested. It is also illustrated by diagrams, every one of which is of real practical value to the student. To those requiring a good general knowledge of Physiology or preparing for the higher examinations we strongly recommend the volume now before us.

S. H.

ZOÖLOGY.

The Romance of the Newfoundland Caribou; an intimate account of the Life of the Reindeer of North America.—By A. A. Radclyffe Dugmore. 191 pages. 73 illustrations and a map. 11-in. × 7½-in.

(W. Heinemann. Price 12/6 net.)

If the life-history of all the larger mammals of the world were described as thoroughly and, at the same time, as picturesquely as Mr. Dugmore has depicted, both with the pen and the camera, that of the caribou, or reindeer, of Newfoundland, our knowledge of natural history would be much fuller than is at present the case; while we should also have a vast store of extremely interesting popular literature in an easily accessible form. So full and comprehensive, indeed, is his work that there really seems little left to say on the subject of wild caribou.

As regards the origin of the term "caribou," the author states that the derivation suggested by the great naturalist, Sir John Richardson, namely, *quarré boeuf*, or *carré boeuf*, meaning "square ox," is incorrect and that the word, in the shape of *maccarib, maccaribo*, or *caribo* is really North American Indian. He is also disinclined to accept the theory that the Newfoundland caribou reached its present home by crossing Belle Isle Strait in winter on the ice. If the theory be true it is quite certain that the migration took place at a much earlier period than has been supposed by at least one writer.

In the wilder parts of the island caribou absolutely swarm; and the author suggests that their number may reach something like one hundred and fifty thousand head. Moreover, they appear to be on the increase. Like the rest of their kind, Newfoundland caribou migrate south for the winter, to return to the higher northern pastures for the summer, where they would have a good time were it not for the countless hosts of mosquitoes and other biting flies, which harass them wellnigh to death. Although grass in summer and reindeer-moss in winter form their staple nutriment, in autumn they feed largely on the leaves of water-lilies and other aquatic plants.

On one occasion, writes the author, "a herd of several caribou swam across the river near where I was hidden; and, coming to the lily-pads, immediately began eating the large leaves. The water was over four feet in depth, so that the animals could not touch bottom. They bit off the leaves as they swam about, frequently putting their heads entirely under water in their efforts to get possession of a submerged leaf. . . . They reminded me strongly of a herd of moose, except that they did not ever go completely under water; and, of course, they swam much higher and with even less effort."

The volume is lavishly illustrated, many of the photographs and sketches giving a vivid idea of what a magnificent animal is the bull in the full glory of his newly cleaned antlers.

The weakest part of the book is undoubtedly that relating to technical nomenclature and the status of the various local forms of caribou; but, as the author does not pose as a professed systematic naturalist, such slight shortcomings may well be pardoned in an otherwise most admirable work.

R. L.

The Life of the Mollusca.—By B. B. WOODWARD, F.L.S. 158 pages. 32 plates. 1 map. 7¾-in. 5-in.

(Methuen & Co. Price 6/-.)

It is something of an achievement to deal with the great group of Mollusca in the small number of one hundred and forty-four pages, but when the writer manages to touch attractively on every important point of interest connected with his subject within that compass he has reason to be proud of his work. Mr. B. B. Woodward has spent many years in studying shells, and not merely these protective coverings, but their inhabitants also. He has never been slow to impart to others some of the pleasure which he has himself taken from his subject, and the science of Malacology or Conchology—call it what you will—should gain many devoted adherents from among those who read "The Life of the Mollusca." They will learn that snails can hear; that the young shell of many forms differs at first from what it becomes afterwards; that the air in the pearly chambers of the nautilus contains more nitrogen than that of the atmosphere. They will gain a very clear idea of the classification and the geological history of Molluscs, with an estimate as to the number that exists, and perhaps the most interesting of all to them will be the chapter on the habits of these creatures and the one dealing with "Instinct, Intelligence, and Uses." Mr. Woodward is so lucky as to have in his possession the original drawings which his uncle, Dr. S. P. Woodward, made for the celebrated "Manual of the Mollusca." From them the author has chosen a number of his illustrations, and these, with others thought necessary to illustrate special points (mostly drawn by Miss G. M. Woodward), serve greatly to embellish the book. On the principle that words of commendation may become an adverse criticism, owing to matters that are left out, we allude to errors so far as to say that the book contains very few.

W. M. W.

Insect Biographies with Pen and Camera.—By JOHN J. WARD, F.E.S. 206 pages. 12 plates. 139 figures. 8¾-in. × 5¾-in.

(Jarrold & Sons. Price 6/- net.)

To the band of English zoölogical photographers who have deserved well of their country belongs Mr. John J. Ward. It has not been his lot to design ingenious contrivances in which to hide from shy birds, nor to hang suspended from the tops of cliffs to obtain negatives of nests, nor, again, to stand in the path of wild beasts with a cinematograph camera; but he has done most careful and interesting work in recording the life-histories of some of our common, but, at the same time, little-known, insects. As we glance through his pictures we recall the pleasure we ourselves had when we first found the delicately stalked eggs of the lace-winged fly, and watched one of the newly hatched young ones climbing down its slender support. We wish, too, that we might have seen the puss moth caterpillar come out of its egg, which is shewn in Figure 16; and no doubt many will be tempted to try and trace the development of the death-watch beetle now that Mr. Ward has shown them the way; but, whether it be of swallow-tailed butterflies showing all their beauty, or commas hiding their wings in order to look like shrivelled leaves, or, again, of the devil's coach-horse beetle bravely attacking the photographer, Mr. Ward's pictures are always as delightful to look at as his descriptions are pleasant to read. An author who uses his own portrait as a frontispiece to a book must expect some criticism, silent thought it may be; and this leads us to a novelty in connection with the book, namely, the "end papers," which consist of a photograph showing Mr. Ward at work with his camera, the picture having been taken by himself. "Insect Biographies" should be in the hands of everyone who takes an intelligent interest in the world around him.

W. M. W.

YEAR BOOKS

Who's Who, 1914. 2314 pages. 8½-in. × 5-in. Price 15/- net.

The Englishwoman's Year Book and Directory, 1914.—Edited by G. E. MITTON. 441 pages. 7½-in. × 5-in. Price 2/6 net.

The Writers' and Artists' Year Book, 1914.—157 pages. 7¼-in. × 4¾-in. Price 1/- net.

Who's Who Year Book, 1914–15. 178 pages. 7¼-in. × 4¾-in. Price 1/- net.

(Adam & Charles Black.)

To the man of affairs who is continually dealing with others who are making their influence felt in the world "Who's Who" is probably the most important of all the year-books, and the additions which have been made of recent years have increased its value. We should mention that the "Who's Who Year Book" contains matter which was originally included in that now much larger volume. In it are given the names of officials, of societies and their secretaries, and even a list of directories and year-books, together with such out-of-the-way information as "Secondary titles of peers not used by heirs" and "Peers' married daughters with titles of their own," not to forget some columns of pseudonyms and pen-names. "The English Woman's Year Book" is the work of nearly fifty expert contributors who deal, as is well known, with all matters of interest to women in connection with education, the professions, social life and work, as well as philanthropy. "The Writers' and Artists' Year Book" gives the name, address, editor, and publisher of all the journals and magazines to which the general writer might wish to contribute; while for the guidance of the latter there is added in each case useful details as to the kind of material wanted, and sometimes as to the payment given. The American and Canadian magazines are also dealt with, and there is an exhaustive list of publishers.

W. M. W.

Whitaker's Almanack, 1914. 1064 pages. 7½-in. × 5-in. Cloth. Price 2/6 net.

Whitaker's Peerage, Baronetage, Knightage, and Companionage, 1914. 867 pages. 7¾-in. × 5-in. Price 5/- net.

(J. Whitaker & Sons.)

To be truly educated, we are told, is not so much to know everything as to know where to find it. Consequently every educated person is conversant with Whitaker's Almanack and appreciates all that it contains. We welcome the appearance of the forty-sixth issue of it and its companion, "Whitaker's Peerage," which is an exceedingly handy volume.

W. M. W.

Who's Who in Science, 1914 (International).—Edited by H. H. STEPHENSON. 662 pages. 9¼-in. × 5¾-in.

(J. & A. Churchill. Price 10/- net.)

Year by year "Who's Who in Science" grows larger, which is to be expected in the case of a book which has so recently come to stay with us, and which deals with the whole world. We think that the Editor is greatly to be congratulated on his labours, and that the book will continue to approach towards perfection. There are still names that might be included, but "Who's Who in Science" should be on the shelves of every active worker.

W. M. W.

Official Year Book of the Scientific and Learned Societies of Great Britain and Ireland. 380 pages. 8½-in. × 5½-in.

(Charles Griffin & Co. Price 7/6.)

If those who are interested in local and scientific societies or wish to join them have need of information they will find it in the "Official Year Book of Learned Societies," and from the lists of papers given in each case they will get some idea of the deeply scientific or more or less popular character of the communications laid before the members. The thirtieth annual issue is in front of us, and is as full of interest as its predecessors.

W. M. W.

NOTICES.

CORRECTION.—In "KNOWLEDGE," Volume XXXVI., on page 451, the descriptions of the larva and pupa of the Musk Beetle should be interchanged.

SCIENTIFIC BOOKS.—The latest list of the Clarendon Press contains, as usual, a large number of scientific books which should be of particular interest to our readers.

PRACTICAL PATHOLOGY.—Messrs. Adam & Charles Black will shortly add to the "Edinburgh Medical Series" a volume on "Practical Pathology, including Morbid Anatomy and Post-mortem Technique," by Dr. James Miller, Assistant Pathologist to the Edinburgh Royal Infirmary.

BINOCULARS AND RAIN-GAUGES.—It is remarkable how many instruments of precision have come into everyday use and may be almost looked upon as part of the domestic equipment. Messrs. Ross' (Ltd.) list contains a number of these, such as prism opera-glasses, sporting telescopes, pocket aneroids, pendant barometers, recording barometers, registering rain-gauges, and thermometers.

BRITISH BIRDS.—As usual, this monthly magazine contains many articles and notes of interest. Mr. Witherby gives details showing how his scheme for marking British birds is progressing. Whereas in the year 1909 the number of birds ringed was two thousand one hundred and seventy-one, in 1913 it had risen to fourteen thousand eight hundred and forty-three, the total for the five years being forty-six thousand eight hundred and twenty-three. Some very useful statistics as to the numbers of birds ringed and recovered up to the present, with the percentage of recoveries, are also given.

LIVINGSTONE COLLEGE.—The annual report of the Livingstone College announces that the Principal, Dr. Harford, who was mainly responsible for its foundation, will resign in the summer of 1914. The twentieth session which has come to a close was marked by the celebration of the centenary of the birth of David Livingstone, and it was decided to raise a centenary fund for the College of ten thousand pounds. The nucleus of this has already been received, and the Committee are determined not only to maintain the position which the College has reached, but develop it in a way that may be of even greater value to the missionary cause.

RESISTANCES.—We have pleasure in calling attention to the catalogue recently issued by Messrs. Isenthal & Company, (running into more than one hundred pages, of rheostats of all kinds, of resistances and regulators for arc-lamps, including those used in connection with projection lanterns) and in saying that in their works in Neasden the firm in question are making many others for special and experimental work; while they are continually introducing new types to meet the ever-increasing requirements of electrical industry, especially in connection with radio-telegraphy and high-frequency work.

MR. C. BAKER'S SECOND-HAND LIST.—The January number of the classified list of second-hand instruments, which Mr. Baker issues three times a year, has just reached us. It contains a very large number of pieces of apparatus which are for sale second-hand, or which, if they are only wanted temporarily by the student, can be had on hire. There are physical instruments, including those used in optics, spectroscopy, the determination of time, velocity, heat, and pressure. There are surveying instruments, telescopes, photographic apparatus, and a very fine series of microscopes, accessories, and objectives. Specially full details are given of the objectives and eyepieces, including the catalogue and present prices, and it must be remembered that, although the difference between the two is considerable, Mr. Baker guarantees every instrument in this department to be in adjustment.

ADDITIONS TO THE MENAGERIE OF THE ZOOLOGICAL SOCIETY.—Three hundred and fifty additions to the Zoölogical Society's collection at Regent's Park were registered during the month of November. Among the most notable were the following: A White-tailed Guereza (*Colobus caudatus*), from East Africa, new to the collection, presented by G. St. J. Orde Browne; A Cheetah (*Cynælurus jubatus*), from East Africa, presented by the Duke of Sutherland; a Hybrid between a Black-winged Peacock (*Pavo nigripennis*) and a Domestic Hen (*Gallus domesticus*), presented by Mr. R. P. Wheadon; a pair of Kagus (*Rhinochetus jubatus*), from New Caledonia, presented by the Marquess of Tavistock; two Masai Ostriches (*Struthio massaicus*), from East Africa, purchased; and a Crowned Pigeon (*Goura coronata*), bred in the menagerie.

WICKEN FEN.—If the sanctuaries for wild life which are being instituted in this country are to be successful it is of the utmost importance that they should be properly preserved. That is to say, there should be one or more keepers always on the watch to circumvent the bird-catcher and the collectors of eggs and plants. In 1911 the late Mr. G. H. Verrall bequeathed his property, of about nearly two hundred and forty acres, in Wicken Sedge Fen and St. Edmund's Fen to the National Trust. The latter is now appealing for funds to restore and preserve the fen, which is of great interest to botanists and zoölogists on account of the rare birds, insects, and plants to be found there. It is as well not to publish details of these before the ground is given the necessary protection which we hope the generosity of those who love wild life will soon ensure. It is estimated that the interest derivable from a sum of two thousand pounds would be sufficient to meet all expenses. The Secretary of the National Trust is Mr. S. H. Hamer, and his address is 25, Victoria Street, S.W.

THE BRITISH ASSOCIATION.—For the Australian meeting of the British Association in August of this year, under the presidency of Professor W. Bateson, F.R.S., the following presidents of sections have been appointed:

Section A (Mathematics and Physics).—Professor F. T. Trouton, F.R.S.

Section B (Chemistry).—Professor W. J. Pope, F.R.S.

Section C (Geology).—Sir T. H. Holland, K.C.I.E., F.R.S.

Section D (Zoölogy).—Professor A. Dendy, F.R.S.

Section E (Geography).—Sir C. P. Lucas, K.C.M.G.

Section F (Economics).—Professor E. C. K. Gonner.

Section G (Engineering).—Professor E. G. Coker.

Section H (Anthropology).—Sir Everard im Thurn, K.C.M.G.

Section I (Physiology).—Professor C. J. Martin, F.R.S.

Section K (Botany).—Professor F. O. Bower, F.R.S.

Section L (Educational Science).—Professor J. Perry, F.R.S.

Section M (Agriculture).—Mr. A. D. Hall, F.R.S.

MR. HAGENBECK'S EXHIBITION AT OLYMPIA.—Not very long ago (in "KNOWLEDGE," Volume XXIV, page 257) we had a very interesting illustrated article on the gigantic geological models which the late Mr. Carl Hagenbeck set up in his famous animal park at Stellingen, near Hamburg; and recently we have been reminded of the great improvements which have been introduced there in the way of enabling visitors to see the living animals without the intervention of bars and railings. In fact, the new terraces at our own Zoölogical Gardens in Regent's Park have, through the energy of Dr. Chalmers Mitchell and the generosity of Mr. Mappin, been modelled on this plan. Now we are being shown by Mr. Hagenbeck's son at Olympia how his father's methods can be applied inside a building. Many fine animals are on view, including lions on a "mountain" surrounded by a trench; a pygmy hippopotamus; and a very large orang-utan. The trained chimpanzees should also be specially mentioned. We hope later to deal more fully with the matter.

SCIENTIFIC INSTRUMENTS.—A number of lists of apparatus manufactured by the Cambridge Scientific Instrument Company have come to hand, which are of considerable interest as marking the progress which is being made in this country. We may mention some of the details. List Number 114 deals with temperature measurement by mercurial thermometers, and it is announced that the applications of these to various industrial processes will shortly be published in separate leaflets. List Number 105 is concerned with the Rosenhain calorimeter, which provides a simple and accurate method for the determination of calorific of coal and liquid fuels. Number 116 describes the latest form of oscillograph, and Number 125 is a list of lantern slides of oscillograms. Number 121 deals with the apophorometer, a sublimate measurer designed by Professor Joly for rapid chemical analyses. Other publications contain details of physiological and electro-cardiographic apparatus, as well as "The Rivers-McDougall Fatigue Machine," which provides reliable methods of registering the amount of distraction of attention due to mental fatigue or to the influence of disturbing sensory stimuli.

A PHILATELIC MICROSCOPE.—In a supplementary list which we have received from Messrs. W. Watson & Sons details are given of a microscope designed by Mr. Harold S. Cheavin, F.R.M.S., for the use of stamp collectors, who have hitherto had to rely on pocket lenses in working out the details of engraving and other minutiae which go to prove the authenticity of any particular specimen. The instrument is not expensive, can be used for other purposes, and is easily made available for taking photo-micrographs. The same list contains a description and figures of several other pieces of apparatus, including a new swing-out fitting for the condenser, and an objective changer which works like a three-jaw lathe chuck. One advantage of the latter is that it does not increase the body length of new microscopes and some existing ones to which it can be fitted. Another important addition to the list is a duplex eyepiece for the microscope for demonstration purposes. We notice also a new electric lamp for microscopy, a reflector polariser designed by Mr. F. J. Cheshire to go on to the tail-piece of the microscope in place of the mirror, and to obviate the use of large prisms of Iceland spar, the price of which is continually increasing. Some improvements which Mr. J. W. Gordon has introduced into his diffraction micrometer eyepiece tend to greater efficiency and more rapid working in this piece of apparatus, which concludes the list.

ROYAL INSTITUTION.—In January, at the Royal Institution, Professor H. H. Turner, Savilian Professor of Astronomy, Oxford, will continue a course of experimentally illustrated lectures, adapted to a juvenile auditory, entitled "Journeying by Telescope"; "Visits to the Moon and Planets," "Our Sun," and "The Stars," on the 3rd, 6th, and 8th respectively. Among other lectures which will be given before Easter are six by Professor W. Bateson, Fullerian Professor of Physiology, Royal Institution, on "Animals and Plants under Domestication"; two by Dr. W. McDougall on "The Mind of Savage Man" (illustrated by the pagan tribes of Borneo); two by Professor Sir Thomas H. Holland on "Petroleum Supply from the Geological Point of View"; three by Professor C. F. Jenkin on "Heat and Cold"; two by Dr. C. W. Saleeby on "The Progress of Eugenics"; two by Dr. J. A. Harker on "The Electric Emissivity of Matter"; and six by Professor Sir J. J. Thomson, Professor of Natural Philosophy, Royal Institution, on "Recent Discoveries in Physical Science."

The Friday evening meetings will commence on January 23rd, when Professor Sir James Dewar will deliver a discourse on "The Coming of Age of the 'Vacuum Flask.'" Succeeding discourses will probably be given by Mr. H. Wickham Steed, Dr. H. S. Hele Shaw, Professor J. Norman Collie, Professor W. A. Bone, Rev. Canon J. O. Hannay ("George A. Birmingham"), Sir Walter R. Lawrence, Bart., the Right Hon. Lord Rayleigh, Professor J. A. Fleming, Professor Sir J. J. Thomson, Dr. A. Keith, and others.

THE ALCHEMICAL SOCIETY.—The eighth general meeting of the Alchemical Society was held on Friday evening, December 12th, the chair being occupied by Mr. H. Stanley Redgrove, B.Sc., F.C.S. Dr. Elizabeth Severn and Sir Richard Stapley were elected Honorary Vice-Presidents of the Society. A highly interesting paper by Professor Herbert Chatley, B.Sc., of Tangshan Engineering College, North China, was read, dealing with "Alchemy in China." It was pointed out in the course of this paper that views similar to those of the mediaeval alchemists of Europe had been current in China since the year 500 B.C., or even earlier. The Chinese alchemists regarded gold as the perfect substance, and believed in the possibility of transmuting base metals thereinto. They also agreed with European alchemists in employing bizarre symbols in their writings; in predicting a spiritual influence as a necessity for the alchemist; in requiring astrological correspondence of operations; in using mercury as the basis in attempting to prepare the philosopher's stone; in believing in the slow, natural development of gold from other metals; in associating asceticism with immortality; and, above all, in postulating a sexual generation for all things. Professor Chatley's paper contained many interesting particulars concerning this last tenet of the Chinese alchemists—the doctrine of Yin and Yang—as well as others respecting their views concerning the Elixir of Life, in the possibility of obtaining which they firmly believed. The full text of the lecture is given in the December number of the Society's Journal.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

FEBRUARY, 1914.

ARTIFICIALLY INDUCED PEARL-PRODUCTION.

By H. LYSTER JAMESON, M.A., D.Sc., Ph.D.

The studies of the last dozen years or so directed to the elucidation of the mechanism of pearl-production, and of the pathological conditions which induce or favour it, have made it increasingly clear that the production of a pearl is not, as was formerly largely believed, the direct result of the effort of the mollusc to cover over with nacre an irritating foreign body (*e.g.*, a grain of sand or a parasite), but rather of the presence in the subcutaneous tissues of a portion of the shell-secreting epidermis, in the form of a closed sac, which need not necessarily be associated with any foreign body. The factors that determine the presence or otherwise of such an epidermal "island" seem to differ in different species of molluscs, and in the same species in different localities. The case in which the chain of causation is most fully known is that of the pearls formed through the agency of the trematode *Gymnophallus* in the common mussel, *Mytilus edulis*, worked out by the present writer in 1902 (*P.Z.S.*, 1902, Vol. I, pages 140-166), in which case the mollusc normally surrounds the parasite, while still alive, with a closed sac composed of the outer shell-secreting epidermis; and this sac, on the death of the parasite, or on its migration to another part of the host, lays down concentric layers of the shell substance, so forming a pearl. The fact that *Gymnophallus* invariably becomes surrounded by such a sac, after settling down in the mussel, and that other parasites and foreign bodies do not normally share the same fate, pointed to the conclusion that the formation of the pearl-sac, and consequently of the pearl, is due to some peculiar or specific stimulation on the part of the parasite, and not to mere mechanical irritation, such as would arise from the presence of any foreign body. But the nature of this stimulation, whether mechanical (as, *e.g.*, by the parasite habitually carrying in with it a portion of the epidermis) or toxic (*i.e.*, resulting from an abnormal growth of epidermal cells induced by some specific secretion of the parasite and comparable to the production of plant-galls), is a question which still awaits further investigation.

The artificial production of pearly excrescences, or blisters, on the interior of the shell, by introducing between the mantle and the shell beads or metal images, which become coated over with nacre, has long been practised by the Chinese, and has been developed into a flourishing industry by the Japanese, whose "culture pearls," formed over a core of mother-of-pearl, are now familiar objects in cheap European jewellery. The secret process devised by Linnaeus for producing pearls in fresh-water mussels was analogous to these methods, though never commercially developed; and similar enterprises have been attempted in Burma and

elsewhere. All these processes have, however, so far only resulted in the production of pearly excrescences, or blisters, on the shell; and the successes in the production of free pearls in this manner, which have been claimed from time to time, have not been scientifically demonstrated. Recently, in Japan, Mr. Mikimoto is stated to have produced a few small free pearls by artificial means, but the method adopted has not been disclosed, and success on anything like a commercial scale has not been achieved.

The production of free pearls by mechanical treatment—not, of course, on a commercial scale as yet—has, however, recently been successfully accomplished by Dr. F. Alverdes, working under Professor Korscheldt, at Marburg, and is described in a paper in the *Zoologischer Anzeiger* for September 12th of last year.* The method adopted by Dr. Alverdes was the introduction, by injection into the mantle-parenchyma, of fragments of the shell-secreting epidermis. The molluscs upon which he operated were the freshwater pearl-mussel (*Margaritana margaritifera* L.), which is still fished for pearls in some of the rivers of Scotland and Ireland, the common pond-mussel (*Anodonta*), and the river-mussel (*Unio pictorum* L.).

The method of treatment was as follows. The shell was held open with a wedge, a portion of the mantle margin was detached from the shell (to which it is normally bound by the reflected margin of the periostracum), and fragments of the outer shell-secreting epidermis of the mantle were scraped off with a knife; in other cases a small disc of tissue, containing both the shell-secreting epidermis and the ciliated lining of the mantle-cavity, was cut out. These fragments of epidermis, with the connective tissue which remained adherent to them, were then injected into the loose connective tissue of the mantle of the mussel.

After treatment the molluscs were returned to their native waters, where they were kept in suitable enclosures. They were killed, and examined at intervals ranging from two days to twenty-seven weeks. The wound caused by the injection was quickly healed by the migration of wandering cells, to form a scar, leaving intact the introduced "island" of epidermis (see Figures 31 to 33), with such connective tissue as happened to have remained attached to it. These "islands" did not, as might have been expected, fuse with and become indistinguishable from the autochthonous tissues, but remained sharply marked off from them throughout, and no actual concrescence between the transplanted and the autochthonous connective tissue seems to have taken place. Dr. Alverdes found that, when the injected epidermis came to lie with the free surfaces of the cells against the autochthonous connective tissue, it died in a short time. If, however, a fragment of epidermis found its way into one of the cavities which occur in the parenchyma it survived, and spread out around the cavity as though endeavouring to cover over the exposed connective-tissue surface with epidermis, in a manner recalling that figured by the present writer in the developing trematode-sac in *Mytilus* (*loc. cit.*, Plate XIV, Figures 2 and 3). Alverdes considers that the process here involved is not due to a multiplication of the epidermal cells by mitosis, but to a flattening out of the cells, mitotic figures first appearing after the cavity is completely lined with epidermis. By the growth of the epidermis around the cavity in the parenchyma a closed pearl-sac is formed; and then the growth therein of a pearl follows naturally from the normal secretion of this epidermis. If the space lined with epidermis is more or less spherical, so is the pearl; if it is irregular, a pearl of irregular shape results.

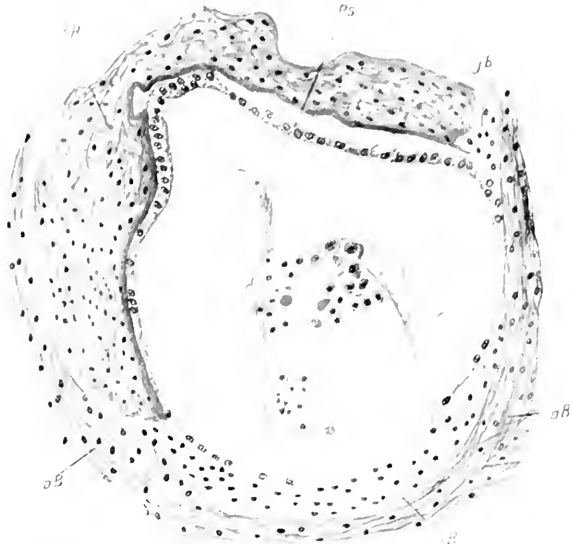
The growth of the pearl-sac takes place with remarkable rapidity, being completed in from two to fourteen days. This point is of interest as helping to account for the great difficulty that has been experienced by all workers on the subject in searching for the earliest stages of pearl-sac development in nature.

Cysts were also formed by the ciliated epidermis, which lines the mantle-cavity, when successfully injected. It would be interesting to pursue experiments with this tissue, to ascertain whether these ciliated cells would retain their original characters, or whether under any circumstances they are capable of giving rise, either by direct transformation or by cell-division, to shell-secreting epidermis.

The size of the pearls which Dr. Alverdes produced depended, in the first instance, on the sizes of the cavities into which the injected epidermal fragments found their way. They ranged from 30 μ to 1 mm. in diameter. In some cases the secretion of pearly substance in the sac began a few days after the operation; in others it had not started after seven and a half weeks (see Figure 33).

Quite apart from the interest which attaches to so important a step in the direction of the solution of the economic problem of artificial pearl-production, and to the achievement of an end which has long been foreseen by zoölogists, the theoretical value of these experiments is considerable, as adding one more link to the chain of evidence that goes to show that the real determining factors of pearl production are to be sought, not in the efforts of the mollusc to coat over with nacre any intrusive body, but in the presence in the sub-epidermal tissues of an island of epidermal tissue which may have arrived there as a result of purely

* Versuche über die künstliche Erzeugung von "Mantelperlen" bei Süsswassermuscheln. *Zool. Anzeiger*, Bd. XLII, Nr. 10, SS. 441-458.



The pearl ... not yet ... the epidermal epith- elium Ps being absent from one side of the cavity (at the bottom of the figure).

FIGURE 51. Section through ... in *Anodonta* ...

FIGURE ... Section ... newly produced p... which a pearl has n... ... Remains of ... in the centre of ... tB = Transplanted ... Seven ... a ...

FIGURE 52. Section of an artificially produced pearl ... *Margaritana.* × 54. A dark foreign "nucleus" accidentally introduced ... in the ... connective tissues. Twenty-... after ...

FIGURE 34.

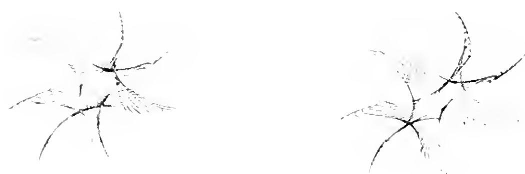


FIGURE 35.

FIGURE 36.

Harmonics rendered stereoscopic by applying harmonious oscillatory movement to one of the figures during the simultaneous tracing of the two curves.

Harmony 2 : 5. Counter current.

mechanical processes, as in Dr. Alverdes' experiments, or of the specific action of a particular kind of parasite, as in the case of *Mytilus*, or, as is suggested by Rubbel's recent work on *Margaritana* and allied forms, from some obscure derangement of the normal shell-secreting mechanism. In the pearls produced by Alverdes a "nucleus" was only present when some foreign matter (*e.g.*, quartz grains) was accidentally introduced along with the epidermis, or when cells, derived from the mollusc itself, became isolated in the lumen of the sac, and consequently embedded in the pearl.

Whether Dr. Alverdes' results as they stand are capable of economic application is, as he himself admits, doubtful, owing to the small percentage of pearls of good quality that are likely to be produced; but unquestionably he has brought the solution of the problem of the artificial production of marketable fine pearls by mechanical treatment of the mollusc much nearer than it was before.

A NEW METHOD OF PRODUCING STEREOSCOPIC HARMONOGRAPH CURVES.

By CHARLES E. BENHAM.

A SIMPLE method of producing very perfect stereoscopic effects is applicable, not only to the ordinary Tisley harmonograph, which compounds rectangular movements, but equally to the twin-elliptic pendulum, either Goold's or Benham's miniature form.

The method consists in using two pens on separate levers, working simultaneously, in the manner shown in Figure 37, which illustrates the attachments in the case of Benham's miniature twin-elliptic pendulum. It is obvious that if each pen traces the figure on a fixed card the two tracings will be identical; but if one pen traces on a fixed card and the other on a card mounted on the top of an oscillating pendulum, swinging in one plane only, there will be lateral displacements in the second figure. This lateral displacement may be either discordant with the harmonograph or concordant with one of its movements. If the oscillator is tuned to unison with the main pendulum of the harmonograph the displacement will be equivalent to a uniform slight difference of phase throughout the figure, which is exactly what is required to give a perfect stereoscopic effect, and at the same time the horizontal level of the corresponding parts of the two curves will be preserved, the displacement being only lateral. If the oscillator is discordant a very interesting result is obtained. The amount of stereoscopic relief under these conditions will vary in different parts of the figure with the alternate coincidence and interference of the respective movements of oscillator and harmonograph, the effect in the stereoscope being one of a solid curve thrown into curious undulations which correspond with these alternate coincidences and interferences.

The amplitude of the oscillator's movement must be only small—just sufficient to produce a slight difference in the two figures. Experiment soon reveals the maximum amount of movement admissible. It is important to secure two pens that give an exactly equal line, and to arrange for their starting together. This latter difficulty is easily got over by superposing a loose leaf of paper on the two cards, starting the pair of tracings

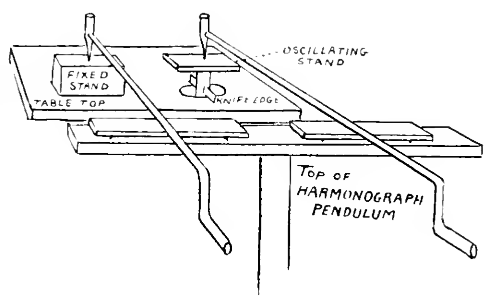


FIGURE 37.

Showing attachments to a Benham's Twin Elliptic Pendulum for stereoscopic curves. The two pens work simultaneously, the one tracing on a card on a fixed stand, the other on a card attached at the same level to the top of a long pendulum oscillating laterally.

on this, and, after the pens have commenced, deftly drawing the loose sheet of paper away in such a direction that both pens commence exactly together on their respective cards.

The pairs may afterwards be mounted, bearing in mind the importance of placing them level with each other and with the displacement lateral.

In Figures 34 to 36 three sets of stereoscopic harmonograph curves are given.

SOME NOTES ON THE CHEMISTRY OF TOBACCO AND NICOTINE.

By H. STANLEY REDGROVE, B.Sc. (Lond.), F.C.S.

THERE are two chief varieties of the tobacco plant, *Nicotiana tabacum* and *Nicotiana rustica* (see Figures 42 and 44). The flowers of *N. tabacum* are rose-coloured; those of *N. rustica*, which is a smaller plant, are greenish-yellow. The former, the Virginian tobacco, is grown in nearly all temperate and warm countries; the latter is cultivated mainly in the East Indies and Germany. *N. persica*, Persian tobacco (see Figure 43), is now regarded as a variety of *N. tabacum*. The quality of the resulting tobacco varies very greatly, as does also its chemical constitution, according to the climate, soil, method of curing, and so on. The chemical constituents of tobacco are very numerous. Nicotine, combined with malic, citric, and other organic acids, is the chief alkaloidal constituent, but small traces of other alkaloids, namely, nicotinine, nicoteïne, nicotelline, pyrrolidine, and methyl-pyrrolidine, have also been detected. Cellulose and calcium pectate, which serve to give stability to most plant structures, are, of course, to be found in tobacco, as are also albuminoids, resins, chlorophyll, phlobophane, and other complex organic bodies. In addition to calcium, potassium and magnesium also occur, as well as traces of the salts of other metals and ammonium; and in addition to the acids already mentioned, oxalic, acetic, tannic, nitric, silicic, phosphoric, sulphuric, and carbonic are present in the form of various salts. Certain tobaccos also contain a high percentage of saccharine matters, as well as starch.

The results of very complete analyses of a large number of different qualities of tobacco were published in 1887 by Dr. James Bell, Principal of the Laboratory at Somerset House*; and, although the methods of analysis adopted in this undertaking have in certain cases been improved on, the results are still of considerable interest. A few of them are given in Tables 5 and 6. It must be understood, however, as Allen points out in his standard work on chemical analysis, that no chemical analysis can serve as a criterion of the quality of tobacco, since so much depends upon minor differences, such as those of colour, texture, aroma, and so on. For this reason only moisture, ash, and oils are estimated in actual practice, the percentages of these being required for revenue purposes.

Pure nicotine, $C_{10}H_{14}N_2$, is a colourless oil, with a sharp burning taste and a faint ethereal odour. On exposure to air it turns brown and acquires the characteristic odour associated with it in the minds of smokers. It boils at 247° C., and at 15° has a specific gravity of 1·011. It is an optically active body, the naturally occurring variety being laevorotary. Landolt gives $[\alpha]_D^{20}$ as $-161·55$, the more usually accepted value is $-166·39$, whilst F. Ratz[†] more recently gives $[\alpha]_D^{20} = -169°·54$ as the optical activity of a specially purified specimen. Nicotine readily dissolves in water, with which it has been found to form a definite hydrate.[‡] It easily passes into vapour in the presence of steam, and this property was mainly made use of in the older methods of estimation.

Nicotine is an excessively violent poison, its action in the pure state being at least as rapid as that of prussic acid. Even in quite small quantities it may produce very unpleasant symptoms, as most smokers are aware from the memory of their first pipe. By continued use, however, the system becomes to some extent protected against the poisonous effects of nicotine; though there can be no question but that the immoderate use of tobacco is highly injurious. On the other hand, the testimony of most moderate smokers is to the effect that such excessively small doses of nicotine as they thereby imbibe are beneficial to the nervous system, and it is a fact beyond dispute that smoking has proved of very great benefit in cases of neurasthenia and insomnia, where other alleged remedies have shown themselves to be useless.

"In order to investigate the effects of pure nicotine Dworzak and Heinrich made auto-experiments, beginning with one milligramme. This small dose produced unpleasant sensations in the mouth and throat, salivation, and a peculiar feeling spreading from the region of the stomach to the fingers and toes. With two milligrammes there were headache, giddiness, numbness, disturbances of vision, torpor, dullness of hearing, and quickened respirations; with three to four

* "The Chemistry of Tobacco" (1887).

† *Monatshefte für Chemie und verwandte Teile anderer Wissenschaften*, Vol. XXVI (1905), page 1241.

‡ C. S. HUDSON: *Zeitschrift für physikalische Chemie, Stöchiometrie und Verwandtschaftslehre*, Vol. XLVII (1904), page 113.

milligrammes in about forty minutes there were a great feeling of faintness, intense depression, weakness, with pallid face and cold extremities, sickness and purging. One experimenter had shivering of the extremities and cramps of the muscles of the back, with difficult breathing. The second suffered from muscular weakness, fainting, fits of shivering, and creeping sensations about the arms. In two or three hours the severer effects passed away, but recovery was not complete for two or three days." *

Table 5.

Proximate Analyses of Various Tobaccos dried at 100° C. (Bell.)

Constituents	Virginia (Ripe).	Turkey	Havana	Latakia.	Algerian.	German	Virginia (Bright).	Kentucky.	China
Nicotine	3·86	0·90	3·98	1·17	3·13	3·22	2·20	4·59	2·50
Malic Acid	9·06	4·90	12·11	9·07	8·50	12·94	4·17	11·57	7·46
Citric Acid	3·09	1·90	2·05	2·40	3·45	2·89	1·00	3·40	1·58
Oxalic Acid	1·58	1·38	1·53	1·98	1·61	2·51	1·72	2·03	3·91
Acetic Acid	·80	·14	·42	·36	·37	·34	·35	·43	·31
Tannic Acid...	1·34	3·39	1·13	2·33	1·53	·68	6·32	1·48	3·13
Nitric Acid	·43	·05	1·32	·76	·70	·37	·14	1·88	—
Pectic Acid	7·72	9·62	11·36	6·25	10·46	10·23	7·51	8·22	7·48
Cellulose	10·38	9·72	15·76	10·00	12·93	14·48	12·64	12·48	7·98
Starch	—	6·28	—	·69	—	—	1·73	—	1·54
Saccharine Matters...	—	12·07	—	1·46	—	—	14·59	—	12·93
Ammonia	·05	·05	·49	·10	·13	·32	·03	·19	·04
Soluble Extractive Matter rich in Nitrogen	16·24	13·24	7·74	18·97	12·37	8·10	13·47	13·90	14·35
Insoluble Albuminoids	14·29	5·30	9·75	7·25	5·69	6·62	4·68	8·10	4·49
Resins and Chlorophyll	5·21	7·90	5·15	6·62	4·73	2·13	3·41	1·99	6·02
Oils and Fats	1·07	·49	1·03	1·12	3·38	·89	2·27	2·28	·25
Indefinite Insoluble Matter, chiefly Phlobophane	12·93	9·71	8·68	14·94	11·38	12·56	12·41	13·10	12·61
Mineral Matter	11·95	12·96	17·50	14·53	19·64	21·72	11·36	14·36	13·42

Table 6.

Analysis of the Ash of Various Tobaccos dried at 100° C. (Bell.)

Constituents		Virginia (Ripe).	Turkey.	Havana	Latakia.	Algerian.	German.	Virginia (Bright).	Kentucky.	China.
% of Total Ash on Dry Tobacco (excluding Sand)		14·96	12·92	21·40	18·18	22·17	25·88	12·32	17·98	14·76
Potash	K_2O	34·16	14·51	11·83	19·57	—	—	22·19	16·78	14·44
Potassium Chloride ...	KCl	2·53	19·29	12·68	4·06	37·57	24·98	7·01	2·41	3·73
Soda	Na_2O	·86	·54	·81	·55	·41	—	1·46	·06	·41
Sodium Chloride	$NaCl$	—	—	—	—	1·50	·60	—	—	—
Lime	CaO	18·90	22·54	33·06	34·69	26·38	35·66	21·70	29·51	31·09
Calcium Chloride	$CaCl_2$	—	—	—	—	—	5·89	—	—	—
Alumina	Al_2O_3	·29	·76	·76	·68	·27	·42	·89	·19	·97
Iron, as	Fe_2O	·40	·43	·45	·55	·91	·23	2·44	·82	1·10
Magnesia	MgO	6·74	9·21	5·29	5·53	6·55	6·45	12·44	6·78	12·70
Silica	SiO_2	1·55	2·06	1·07	2·03	1·68	·86	·57	4·94	3·38
Phosphoric Anhydride ...	P_2O_5	3·23	6·39	4·17	3·62	3·73	2·19	4·72	3·86	5·11
Sulphuric Anhydride ...	SO_3	4·32	5·20	4·34	3·67	5·27	3·47	8·29	5·07	4·83
Carbonic Anhydride ...	CO_2	27·02	19·07	25·54	25·05	15·73	19·25	18·29	29·58	22·24
Total		100·00	100·00	100·00	100·00	100·00	100·00	100·00	100.00	100.00
% of Sand on Dry Tobacco.		·95	1·80	1·80	·92	·93	·94	1·28	5·26	2·12

* Alexander Wynter Blyth, M.R.C.S., F.I.C., F.C.S., and Meredith Wynter Blyth, B.A., B.Sc., F.I.C., F.C.S.: "Poisons: Their Effects and Detection" (1906), page 281.

The authors from whom the above account is quoted suggest six milligrammes as probably the fatal dose for an adult not used to tobacco.

There are very few cases on record of poisoning by means of pure nicotine, though one of the few is of historical importance, namely, the murder of M. Fougnies by Count Bocarmé and his wife. This is the first case on record of a pure alkaloid being employed to effect murder. Bocarmé, indeed, had specially taken up the study of chemistry in order to prepare the alkaloid himself. But, as the Blyths remark, "The wickedness and cruelty of the crime were only equalled by the clumsy and unskilful manner of its perpetration." Bocarmé's attempt to destroy all traces of the poison by means of acetic acid was unsuccessful: the famous chemist, Stas, in fact, obtained as much as 0·4 gramme from Fougnies' stomach, showing that the quantity employed must have been excessively great.

Cases of poisoning, both accidental and criminal, by means of tobacco are more numerous, especially the former. Many have occurred through the use of clysters prepared from tobacco, and through external applications of the herb in the form of a poultice, as well as cases in which the poison has been taken through the mouth.

In connection with the physiological action of nicotine, Professor Langley's theory of "receptive substances" must be mentioned. Nicotine is found to produce continued contraction in certain muscles of the bird even after the nerves have been severed. The muscles, however, still respond to direct stimulation, so that, whilst the poison is obviously acting on the muscle and not on the nerves it must be on some constituent of the muscle other than the contractile substance. Analogous phenomena are observed with other chemical reägents, and have led Professor Langley to suggest that in all cell-protoplasm there are present, along with the chief substance concerned with cell-function, receptive substances, which may be acted on by chemical reägents, and can affect the metabolism of the chief substance.

No certain antidote to nicotine poisoning is known, but the above-mentioned muscular contraction is lessened by means of curare, and C. Zalackas* completely counteracted the effect of a fatal dose (twenty-five milligrammes) of nicotine administered to a rabbit by means of two injections of the expressed juice of *Nasturtium officinale*.

The constitution of tobacco smoke has been the subject of some investigation. It consists for the most part of permanent gases, mainly carbon dioxide and carbon monoxide. Hydrogen sulphide, hydrogen cyanide (prussic acid), and ammonia have also been detected. The nicotine is mainly converted into pyridine bases, pyridine (C_5H_5N) predominating in pipe-smoke; collidine ($C_8H_{11}N$) in that of cigars. The latter has a more pronounced physiological action than the former. Part of the nicotine passes into the smoke unchanged.

Various tests have been proposed and employed for the detection of nicotine. Probably the most characteristic is the one due to Schindelmeiser.† One drop of formaldehyde, free from formic acid, is added to the alkaloid suspected to be nicotine, which must be free from resinous matter; then one drop of concentrated nitric acid is added. A deep rose-red colour indicates the presence of nicotine.

Nicotine may also be detected by the aid of the microscope, since certain of its salts crystallise in characteristic forms. This subject has been investigated very fully by Wormley,‡ to whose work I am indebted for Figures 39 to 41 shown herein. In each case the magnification is forty diameters. Figure 39 shows the characteristic form of the double chloride of nicotine and platinum, $C_{10}H_{16}N_2PtCl_6$, produced by the addition of a solution of platinic chloride to a one per cent. solution of nicotine in water in the presence of hydrochloric acid. Mercuric chloride produces, in a one per cent. aqueous solution of nicotine, a copious white precipitate, soon turning yellow and yielding a mass of crystals. These are shown in Figure 40. Most other alkaloids yield precipitates with mercuric chloride, but they remain amorphous, except in the case of strychnine, which, however, produces crystals of quite a different form.

Picric acid in alcoholic solution yields a precipitate, which soon becomes crystalline, with even very dilute aqueous solutions of nicotine. Figure 41 shows that produced in a 0·1 per cent. solution of the alkaloid. The only picrate with which it is likely to be confused is that of sodium.

The estimation of nicotine is of considerable commercial importance, because insectides prepared from tobacco, in which this alkaloid is the essential ingredient, are now in large demand. Considerable attention has been directed to this subject of late years. The older methods of estimation, as already mentioned, made use of the ready volatility of nicotine in steam in order to separate it from the other ingredients of the preparation to be analysed; but steam distillation suffers under the disadvantage that any ammonia present is also carried over. In

* *Comptes rendus hebdomadaires des Séances de l'Académie des Sciences*, Vol. 140 (1905), page 741.

† *Pharmaceut. Zentralhalle*, Vol. XL (1899), page 703. See Allen's "Commercial Organic Analysis," Vol. VI (1912), page 239.

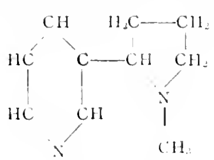
‡ THEODORE G. WORMLEY, M.D., PH.D., LL.D., "Micro-Chemistry of Poisons, including their Physiological, Pathological, and Legal Relations, etc." (Philadelphia and London, 1885).

Tóth's method* the mixture to be analysed is triturated with caustic soda solution, and plaster of paris is worked in to form a dry mass which will not "bind" when pressed into a lump. This process eliminates any ammonia which may be present. The mass is then extracted by shaking in a stoppered bottle with a mixture of equal volumes of ether and petroleum ether. A known proportion of the fluid is drawn off, diluted with water, and rendered acid by the addition of a known volume of standard acid. The excess of acid is then estimated by trituration with standard alkali, using iodeosin or lacmoid (Kippenberger) as indicator. From the amount of acid used to neutralise the extract the amount of nicotine present may be calculated.

Kissling proceeds in a somewhat similar method to the above; but he extracts with ether alone in a Soxhlet apparatus, evaporates the ether, takes up the residue with dilute caustic soda solution, distils the solution in a current of steam, and triturates the distillate, which contains the whole of the nicotine in a free condition, with standard sulphuric acid. His method has the advantage over that of Tóth that the difficulties of triturating a mixture of water and ether are thereby obviated, and it has been officially adopted.

Degrazia† has devised a polarimetric method of estimating nicotine, whilst Bertrand and Javillier‡ make use of the fact that nicotine may be completely precipitated by means of silicotungstic acid.

Nicotine was discovered by Passelt and Reiman in 1828. In 1891 Blau prepared a compound resembling nicotine, but which was shown not to be chemically identical therewith. The problem of the chemical constitution of nicotine was investigated by this chemist, and more especially by Pinner, who, as the result of a number of experiments, came to the conclusion that nicotine is α-pyridyl-β-tetrahydro-N-methylpyrrol; that is to say, its molecule is represented by the formula:



The accuracy of this formula was conclusively proved by the brilliant research of Amé Pictet and Rotschy,§ who, in 1904, succeeded in preparing nicotine synthetically.

Their method was as follows (see Figure 38): Nicotinic amide (II) was obtained from nicotinic acid (I), and converted by the action of caustic potash and bromine into β amidopyridine (III). This was combined with mucic acid, and on dry distillation yielded N-β pyridylpyrrol (IV). Now Pictet had already shown that N pyrrol derivatives become α derivatives when heated in a hot tube, thus:

The N-β-pyridylpyrrol was therefore converted into $\alpha\beta$-pyridylpyrrol (V) by this method, and on treatment of the potassium salt with methyl iodide, $\alpha\beta$-pyridyl-N-methylpyrrolemethiodide (VI) was obtained. This body is identical with the methiodide of nicotyrine, which latter compound is produced when nicotine is carefully oxidised. On

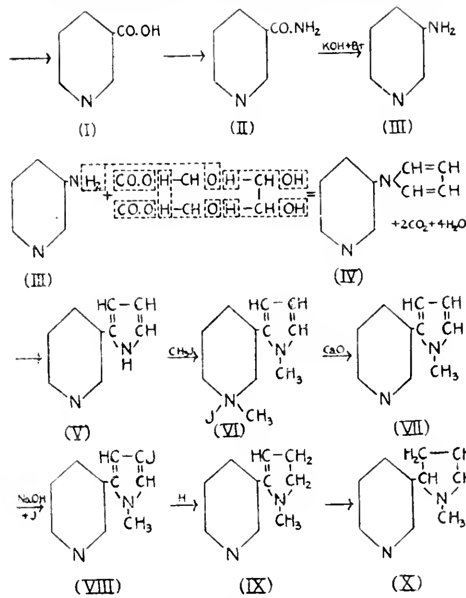


Figure 38.

careful distillation with lime the methiodide of nicotyrine yields the parent body, so the next problem was to convert nicotyrine into nicotine. This was effected as follows: The nicotyrine (VII) was treated with caustic soda and iodine, with the production of an iodine substitution product (VIII), which was reduced with zinc and hydrochloric

* *Chemiker-Zeitung*, Vol. XXV (1901), page 610.

† *Fach. Mitt. österr. Tabakregie* (1910), page 87; see *Journal of the Chemical Society*, Vol. C (1911), Part II, page 671.

‡ *Bulletin de la Société Chimique de France*, Series 4, Vol. V (1909), page 241.

§ *Berichte der deutschen Chemischen Gesellschaft*, Year XXXVII, Part II (1904), page 1225. Some of the earlier part of the work was done by Pictet and Crépieux, *loc. cit.*, Year XXVIII, Part II (1895), page 1904.

acid to dihydronicotyrine (IX). The perbromide was prepared and reduced, yielding α pyridyl β-tetrahydro-N methylpyrrol (X). This body was found to be chemically identical with naturally occurring nicotine. Of course, it was optically inactive, but it was resolved into its optically active isomers by fractional crystallisation of the tartrates. The optical activity of the laevo-nicotine thus obtained was found to be $[\alpha]_D^{20°} = -160{\cdot}93$, thus differing but slightly from that of the natural variety, whilst that of the dextro-nicotine was $[\alpha]_D^{20°} = +163{\cdot}17$. The dextro-variety was found to be less violent in its physiological action than that of the laevo-nicotine; thus, whilst the injection of the laevo-base into a guinea-pig resulted in cramp and violent pains in the extremities, the injection of the dextro-variety appeared to produce no pain. This is seen to be less remarkable than it appears at first sight, when we remember that the bodies of living beings contain very many optically active bodies whose reäctions to optically active isomers may well be expected to be different.

CORRESPONDENCE.

THE LONDON MUSEUM

To the Editors of "Knowledge."

Sirs,—May I trespass upon your space to quote a paragraph from a recent London publication?

"It was anticipated that Stafford House, the new home of the London Museum, would be opened this year (1913), but labour and strike troubles have so retarded the work of alteration that the building will not be ready until early in 1914. Mr. Guy Laking, the keeper of the Museum, states that the exhibits will be *very differently arranged* compared with Kensington Palace. *Instead of being classified and set out in sections they will be shown in chronological order.* Thus the visitor on entering the house will first view the pre-historic exhibits, and then pass on to those of successive periods. The Roman boat, which was found near Westminster Bridge a year or two ago, will be in the basement."

From the portion italicised it seems that the keeper of the Museum now admits that the collection at Kensington Palace was not arranged chronologically, which was the contention in my notes sent to you a little time ago. It is pleasing to find that the keeper's own opinion with regard to the arrangement of his collection is now changed, and is more in accord with that of many others, including that of

A PROVINCIAL CURATOR

A PLANETARY PHENOMENON.

To the Editors of "Knowledge."

Sirs,—The enclosed extract is taken from Savage Landor's last book (Vol. I), and if you can explain it it will, I think, prove interesting

"At night, while back in camp, we saw to the W.N.W. quite low on the horizon, a brilliant planet, possibly Venus. The stars and planets appeared always wonderfully bright and extraordinarily large on fine nights. Whether it was an optical illusion or not I do not know, but the phenomenon, which lasted some hours, was seen by all my men, and appeared also when the planet was seen through a powerful hand telescope. It seemed to discharge powerful intermittent flashes, red and greenish, only towards the Earth. Those flashes were similar to, and more luminous than the tail of a small comet, and, of course, much shorter—perhaps four to five times the diameter of the planet in their entire length. Whether this phenomenon was due to an actual astral disturbance, or to light-signalling to the Earth or other planet, it would be difficult—in fact, impossible—to ascertain with the means which I had at my command. Perhaps it was only an optical illusion caused by refraction and deflected rays of vision owing to the effect upon the atmosphere of the heated rocky mass by our side and under us, such as is the case in effects of mirage. I am not prepared to express an opinion, and only state what my men and I saw, merely suggesting what seem to me the most plausible explanations. At moments the planet seemed perfectly spherical, with a marvellously definite outline, and then the flashes were shot out, especially to the right, as one looked at the planet, and downward slightly at an angle, not quite perpendicularly. That night (May 25th-26th) was cold, min. 58 Fahr., day 85 Fahr."

ERNEST GEORGE ROSE.

Bursledon Towers,
Bursledon, Hants.

LUMINOUS BIRDS.

To the Editors of "Knowledge."

Sirs,—I find an article in *The Literary Digest* of October 11th, 1913, entitled "Luminous Birds." The next time that one of these luminous birds is obtained I would suggest that his feathers be soaked in distilled water and a test made for lime. The luminosity is doubtless due to lime which has adhered to the feathers from the droppings which have accumulated in his sleeping quarters. Lime when exposed to sunlight has the property of giving off light in the dark.

M. C. WILKINSON.

P.O. Box 443,
San Pedro, California, U.S.A.

THE CHEMISTRY OF THE FOREST.

To the Editors of "Knowledge."

Sirs,—The article by Dr. P. Q. Keegan on "The Chemistry of the Forest" (see volume XXXVI, page 367), is very instructive, but I think his statement is wrong respecting the origin of resin passages in the heartwood of *Pinus*; I think he will find that they form in the autumn growth each year, while the cells are meristematic; and also in the protective tissue. The contents flow through them to any part of the tree and accumulate abundantly where a wound is made. I have never seen active cells in the wood; they are dead when they are ligneous, long before they become heartwood.

The cambium always produces an extra number of cells when a tree has been bruised, exactly where they are most needed; if a branch or trunk is partly broken, the new growth changes its rate of increase because the fracture gives it more freedom in the cortex; the turpentine also flows more easily to the wound.

T. AXON.

Laurel Street, Stockport.

THE CHEMISTRY OF THE FOREST.

To the Editors of "Knowledge."

Sirs,—I am engaged on the study of timber, and I want to find out details of the various secretions contained in each kind of wood; I should, therefore, be very much pleased if I could obtain references to the literature of this subject.

GILBERT R. KEEN.

59, Larkhall Rise, Clapham, S.W.

FIGURE 39. [illegible] gramme of Nicotine [illegible] Chloride.

FIGURE 40. [illegible] gramme of Nicotine [illegible] Corrosive Sublimate.

FIGURE 41. [illegible] gramme of Nicotine [illegible]

Figures [illegible] after Wormley.

FIGURE 42. The Indian Tobacco. *Nicotiana rustica.*

FIGURE 43. Persian Tobacco. *Nicotiana persica.*

FIGURE 44. [illegible]

[illegible]

FIGURE 45. The Bird on the Nest.

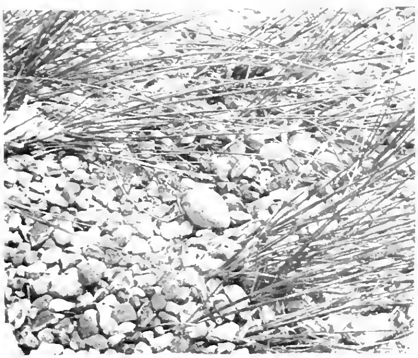


FIGURE 46. Nest, Type 1.

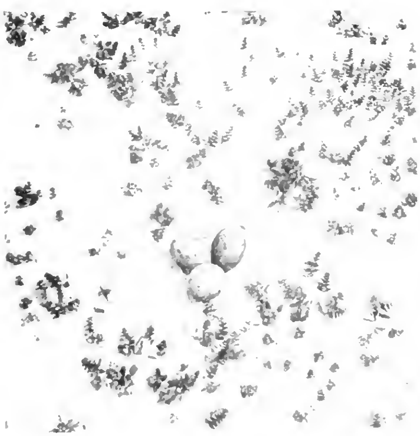


FIGURE 47. Nest, Type 2.

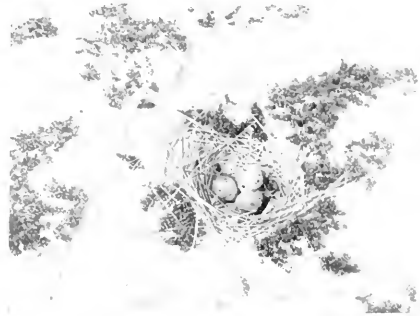


FIGURE 48. Nest, Type 3.

FIGURE 49. Nest of Wood Chips and Shells.

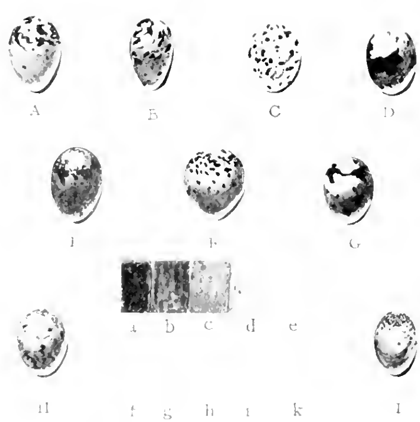


FIGURE 50. Eggs—A-I, types of mottling; a-k, ground colour.

THE COMMON TERN.

SOME OBSERVATIONS ON A TERN COLONY.*

By WILLIAM ROWAN.

THE work of which this is a brief description was carried out, in 1913, on Blakeney Point, Norfolk. The idea was to determine, by means of a census, some of the laws that control the choice of site, nesting materials, and pigmentation of eggs. The work of previous years provided the basis for the methods employed. Many improvements in method suggest themselves, and future work should prove of decided value. This is the first systematic attempt at a census, to our knowledge, and, though we know only too well the many weak points therein, we publish the results as much as a suggestion to ornithologists as for any other reason. The work involved is long and tedious, and results are few.

Blakeney Point is a shingle spit of some eight miles in length. Its extremity projects freely into the sea. On the seaward edge of the terminal mile and a half there is a large open shingle beach; further in are sand dunes, and on the landward side of these are salt marshes and mud flats. At high tide there are nearly two miles of water between these and the mainland.

It was on the seaward side of the dunes on the open shingle that the famous old colony of Terns took up its quarters this year, though there were a score or so of nests on one of the laterals on the lee side of the dunes. It was on the open shingle that the census was taken.

Before describing the results of the census a remark on the movements of a Tern colony may not be out of place. It must not be imagined that because Terns come to the Point year after year therefore they choose the same part of it every time for nesting—far from it. Their choice varies considerably. A few years ago their favourite nesting site was on the lee side of the dunes. Now, however, this part is deserted. Last year the colony was concentrated round those dunes known as the Tern Dunes; this year, however, it has spread right along the beach, and not a nest was found on the dunes proper, while last year a number were located there. Of course, we are only referring to the common Tern now. The erratic nesting habits of the Lesser Tern are well known. This bird, too, was found in considerable numbers.

Two people only were at work, and the month was July, so that we got only the late birds and two hundred and three clutches in all.† Our method of procedure was this. We marked out certain well-defined patches of shingle and together examined these in strips, passing and repassing each other till the ground had been completely covered, when we moved on to another patch.

Four measurements were taken of each egg: long and short circumference, length and breadth. These were taken for biometrical purposes, also the type of mottling and ground colour. Then the egg was numbered with indelible ink, so that it should not be dealt with again. The number in each clutch was then recorded and the type of nest.

In all two hundred and three clutches were found: one hundred and nineteen of one each, sixty-six of two each, eighteen of three each. Of these thirty were abandoned, and the eggs addled and partially buried. Of the clutches containing one egg each we have no proof as to how many consisted of one originally, or in how many cases the one was merely a remnant of a larger clutch.

Three types of nests were taken: (1) No nesting materials and no hole (see Figure 46); (2) no nesting material, but hole scraped (see Figure 47); (3) materials used (see Figure 48). Of these the following number of nests occurred.

Type.	*Number of Nests.*
1	18
2	38
3	120

Of these at least thirty were abandoned.

Of type 3 twenty-four were large, thirty-nine medium, and fifty-seven slight. The majority were made of dried Psamma and similar materials, but four were found in which shells and pebbles had been used, while one contained a large number of crab-legs. In the marshes the drift-line consists of thousands of dead crabs (*Carcinus maenas*), so that the supply was plentiful. One nest was made almost entirely of wood-chips (see Figure 49). Nine nests were found in growing plants of *Arenaria peploides*, and one in living *Triticum*. Some had nests built, others not.

The Common Tern is doubtless a lazy bird, for in the vast majority of cases nests of type 3 were on the drift-line, or some similar situation where material was plentiful. In two years only one nest was found on the drift-line without any material whatever. This was a clutch of three very dark eggs. Nests of a considerable size, far from the drift or other supply of material, were more plentiful, but far from common.

The next thing studied in great detail was the mottling. From the work of previous years a table of types was drawn up (see Figure 50). These were respectively called A—I. It should be pointed out that the size and shape of the eggs on the figure have nothing whatever to do with the mottling, and will be referred to later. Type C was the

* *Blakeney Point Publication*, No. 10.

† The operations of measurement and recording were carried out in conjunction with Miss K. M. Parker, my colleague in the Blakeney Point Field Section for Faunistics.

commonest, by a long way, with one hundred and five eggs. They come in the following order:

Type.	*Number of Eggs.*
C	105
E	60
B	49
A	27
F	24
H	13
D	8
I	7
G	4

Types with a distinct circle on the round end were A, E, F, and I. They total one hundred and eighteen. This represents nearly thirty-nine per cent. of the total, and the rings are therefore in the minority. One egg was found with the ring half-way down, while two more were found with heavy markings on the pointed end, while the round end was almost free.

Clutches of two eggs each, in which both eggs belonged to the same type of mottling, were in the minority. Out of sixty-six clutches with two eggs each twenty-eight had both eggs belonging to the same type. In the remaining thirty-eight it is remarkable how frequently the types E and C and A and C occur together. The only difference between A and E is that the one has more markings on the lower part of the egg than the other; and, if they be considered as one type only, the frequency of occurrence is even more marked. In clutches of three the percentage of this combination is even higher. Out of thirteen of these clutches only one had all three eggs belonging to the same type of mottling. In type B (see Figure 50) the twist on the markings should be brought to notice. Where it existed this twist was always in the same direction, downwards from the right to the left. The same thing occurs in the eggs of the Lesser Tern, and is undoubtedly connected with the laying apparatus of the parent bird.

In recording the ground colour a graduated scale was used, *a–k*. The eggs were marked according to their shade. On the photograph of the scale (reproduced in Figure 50) the true colour values have unfortunately not come out, and the scale is consequently misleading. On the original the gradation is quite regular.

In clutches of two eggs each the minority had both eggs of the same ground colour. In some cases the difference was enormous. One clutch contained eggs of types *a* and *h* respectively. Others varied to the extent of *c* and *g*, *e* and *i*, *c* and *f*, *b* and *f*. Only a single egg was found to match type *k*.

There were three eggs that could not be accommodated to this scale. One was of a dull slate colour, with mottling also outside the scale. It was with a normal egg. The other two made one clutch. Both were as blue as a thrush's egg. Mottling was also abnormal on both. It is a curious coincidence that both ground colour and mottling should be abnormal on all three eggs.

In clutches of three eggs three clutches had all the eggs of a different ground colour. One clutch had all three eggs alike. Of the other nine, all had two eggs alike; with two exceptions only, these were lighter than the third.

In length the eggs varied from 3·6 centimetres to 4·7 centimetres; in breadth, from 2·6 centimetres to 3·7 centimetres. The smallest egg was the same length, but a little broader than a normal egg of the Lesser Tern (see Figure 50). F on the same figure shows the broadest egg found. It was as broad as the above was long, and not much longer than its own breadth.

No direct connection could be found between types of eggs and types of nest. There may be none. But a point suggested by our work is that a bird laying one type of egg may lay another type also, but not *any* type. There may be a law controlling range of variation possible to one bird. It remains to be proved that, where extreme differences were found, these were produced by the same bird. We found that, where a dark and light egg existed together, the lighter was usually the more heavily marked.

The use of material for nesting, alike in quality and quantity, is probably more according to law than is usually believed.

Other laws suggest themselves, but they cannot be proved till more work has been done on these tedious and somewhat novel lines. Many interesting results should be attainable.

LAWES AND GILBERT CENTENARY FUND.

During the Christmas holidays the Lawes and Gilbert Centenary Fund Committee ceased work so as not to interfere with the ordinary Christmas appeals: it has now begun work again to collect the last £1,600 needed to complete the scheme.

The object of the Centenary Fund is to build and equip a satisfactory laboratory for the prosecution of researches in agricultural chemistry, a subject largely founded on the experiments of Lawes, who was born just one hundred years ago, and of Gilbert, who was born three years later. Those investigators founded the Rothamsted Experimental Station, the oldest, and for many years the best equipped agricultural experiment station in the world. Rothamsted has maintained its high position in respect of its staff and its field plots, but it has fallen behind in laboratory accommodation, and a serious effort is now being made to remedy this defect. The Committee has ascertained that a satisfactory laboratory can be erected and equipped for £12,000, and it has decided to collect the money, and to put up the laboratory this year in commemoration of the centenary of the birth of the founders. Its efforts have been so far successful that only £1,600 is now required; and an urgent appeal is addressed to all interested in agricultural science to aid the Committee in closing the list so that the work can be put in hand at an early date. Subscriptions should be sent to the Secretary, Rothamsted Experimental Station, Harpenden, Herts.

STELLAR SPECTROSCOPY FOR BEGINNERS. IV.

By PROFESSOR A. W. BICKERTON, A.R.S.M.

To understand spectroscopy well, it is necessary to have a slight basic acquaintance with many branches of science. Although good work is often done by persons who have not this basic knowledge, their work is not usually so well correlated as a broader training would have rendered it. Deep specialisation is essential to progress, but its tendency to become detached and vicious has been a striking feature of the immediate past. Nowhere is this tendency more marked than in the learned societies. One rather expected this in the professional societies, but that it should mark the amateur's associations somewhat surprised me three years ago when I landed in England. After a year's effort to effect a change it was seen that a new society was necessary, and the London Astronomical Society was established to correlate facts and found a consistent cosmology. It has already done much basic work in investigating existing theories and in interpreting light curves and spectrograms. A really surprising number of complex spectra are now quite understood.

A magnificently equipped and most favourably situated observatory has recently been opened by one of the members in Hampshire to confirm hypothesis by observations. The unique Hartness Turret Observatory in the United States of America will also be largely devoted to work in conjunction with the London Astronomical Society.

As much of the broadly basic scientific knowledge desirable in the study of spectroscopy is of a simple and interesting character some space will occasionally be devoted to these fundamental preliminaries; and, as graphics are so much more perspicuous than analytics, most of the spectroscopic problems will be treated graphically.

The Order in Complex Spectra.

When one sees the beautiful coloured bands and lines produced by the various elements and their compounds in the spectroscope there appears to be no order at all, and the same is true of spectrograms, except in Secchi's first type of stars. A number of spectrograms of these stars have been already used to illustrate these articles. In these stars the element hydrogen shows a most wonderful order. The general difference between spectrograms—that is, stellar spectra photographs—and the same spectra seen by the eye is that the photograph shows much shorter wave-length than the eye. The order seen in the hydrogen overtones scarcely shows in the visual appearance of their element's spectrum. It is only striking when the rays invisible to the eye are seen in photographs. The longest wave-length of the hydrogen bands seen in most of the spectrograms given in these articles can alone be seen by the eye. In the Sun that line is coincident with the H line of calcium, and so is lost to sight. Although the solar stars do not show this order like Vega and γ Lyrae do, yet in the Worthington spectrogram published in "Knowledge" (Vol. XXXVI, page 115) I am able to trace sixteen of these lines in the transparency which I possess; more than a dozen can be seen in the published enlargement. In this unique spectrum the hydrogen overtones are circles, and are thin lines instead of the broad bands of Vega or other similar stars.

In Figure 52 I have taken γ Lyrae and plotted it as a curve, in which one set of ordinates are at an equal distance apart. It can be seen that these lines become more and more equal in length, and never pass the wave-length of 3645·6.

The obvious harmonic character of the hydrogen overtones in these stars, sometimes called Sirian, has supplied the clue by which order has been evolved from the complexity of other elements. In the spectrum of the Sun no order can be casually detected; but when we come to study in detail Worthington's wonderful solar spectrogram we shall easily see order; so also shall we do when we study and disentangle the apparently orderless complexity of the elementary spectra. Later on we shall deal with this order in greater detail.

Detection of Elements

Amongst so much complexity as we see in solar and stellar spectrograms one might think it would be hopeless for the amateur to try to detect the elements. This, however, is not the case. There are characteristic groups of lines of different tints in many of the elements that are easily recognisable. The double lines of D_1 and D_2 of sodium are markedly characteristic; as is also the single line D_3 of helium when its wave-length or colour is also used. It is seen as a very faint ring at the extreme end of the Worthington spectrum.

The two bands of calcium that mark the end of the visible solar spectrum help to distinguish the hydrogen series, because the longer of the two wave-bands—Calcium H, the one towards the red—is almost exactly coincident with a hydrogen band. In Worthington's spectrum enlargement the two calcium lines show well. The H and K Calcium lines are the two rings in the middle of the enlargement. In Figure 123 in "Knowledge," Volume XXXVI (1913), we have a portion of the solar spectrogram and a series of stars. To the right of

the solar spectrum are seen the two broad bands of calcium. Bands corresponding with one—the broad bands—run all down the series of star spectra. These are Hydrogen ϵ, wave-length A.U. 3970, and Calcium H, wave-length A.U. 3968, whilst Calcium K, wave-length A.U. 3934, is seen as a thin line gradually showing more intensity as we pass from α Leonis to α Aquila.

Many of the lines of the elements run in doublets and triplets of definite colour, and so help in the identification. Of course, some practical work in spectrum analysis is desirable to aid in the detection of the elements. As a rule, a very slight acquaintance with the recognition of elements is all that is necessary to understand stellar spectra; it is the physical characteristics that are chiefly valuable in stellar spectroscopy. It is on this branch of the subject that the New Astronomy of Impact throws so much light.

Whilst much work relating to the detection of the elements is easy, on the other hand some spectra are exceedingly difficult to determine.

Some lines—as those seen in nebulae and called nebulium, and those seen in the corona and called coronium—have never yet been found on Earth at all. The characteristic line of Helium, D_3, was first seen in the Sun, and was not found on Earth until years afterwards. There is a spectrum called "Swan," due to some compound of carbon that is still under dispute, although Baly unmistakably seems to prove it to be carbonic oxide, and lately Fowler has found evidence of the same kind.

Save these and a few other exceptions, most of the lines of spectra, and even those of spectrograms, are fairly well known.

Variation of Spectra with Source of Heat and as Compounds.

The same elements give different spectra when differently treated. They vary with temperature, with pressure, and with the intensity of electric action used. Compounds give different kinds of spectra from elements, and these compound spectra are of two different classes.

Compounds tend to give banded spectra. The spectra of elements generally consist of lines. Banded spectra have also many other characteristics, and line spectra tend to broaden into bands; all these complexities simplify when correlated. The broadened lines of the elements and the bands of compounds have a totally different character. The bands of compounds finish with a sharp edge quite unlike the broadened lines of hydrogen and other elements that finish with a hazy head. This contrast is referred to in detail further on, illustrated by Figures 53 and 54. When the sharp-edged bands of compounds, and also those of some elements, are examined with wide dispersion the bands are found to be made up of lines, and when these lines are more spread out, with wider dispersion are found to become bands.

The solar spectrum can be spread out into a score of yards, and over a score of thousand lines are mapped in Rowland's wonderful charts.

The Simplicity but Great Number of the Problems of Spectroscopy.

The problems before the student of spectroscopy are somewhat similar to these before the student of the New Astronomy of Impact. Most of the problems in each case are simple; the trouble is there are so many of them. The New Astronomy of Impact introduces some sixscore problems, many of them spectroscopic. The majority of these problems offers practically no difficulty. When workers have mastered the fundamental problems of the new astronomy, and of stellar spectroscopy, it will be found that complex spectrograms can nearly all be read as easily and as unmistakably as a printed book. This is true even of such long series spectrograms, so full of striking detail, as the wonderful Cambridge Spectrograms of Novae Geminorum. But our motto must be "Festina lente." (To hurry is to stumble; we shall get along quickly if we take each part separately and allow of no confusion.) First, then, we will try to understand a little more fully the character of the harmonic order of spectra. Figure 52 shows how the series of bands of γ Lyrae suggests a curve that approaches a vertical tangent. When each of these bands is carefully divided on the position of maximum density, and projected upon a series of horizontal lines drawn at equal distances apart, it produces a curve that tends to a vertical finish, which means that the lines of the spectrum crowd in upon one another. But these short waves are so extremely feeble that the head where these lines coalesce is usually invisible.

Balmer has shown that this can be expressed in a formula. Starting from $H\alpha$ to $H\beta$, through γ, δ, ϵ, and so on, the wave-length can be expressed as fractions of the wave-length of the head, 3645 A.U.

That is, $\alpha\frac{9}{5}$, $\beta\frac{16}{12}$, $\gamma\frac{25}{21}$, $\delta\frac{36}{32}$ and so on, up to and past ω; now the top row of figures is $3^2 = 9$, $4^2 = 16$, $5^2 = 25$, and so on; and the lower row is $3^2 - 4 = 5$, $4^2 - 4 = 12$, $5^2 - 4 = 21$, and so on; so, if we put m for numbers in order, from 3 upwards, then the formula is $\frac{m^2}{m^2 - 4}$, and these have certainly been seen up to 29, and some think even further, in stellar spectrograms. Each line as it approaches the head gets more and more indistinct, and so the head or finish of many lines is, as already stated, almost invisible. This is exactly the reverse of the head of the bands of compounds in which the finishing lines are strong.

The heads of the hydrogen series, and of all similar series in the other elements, are towards the violet end of the spectrum. The clear-edged, definite bands of compounds are sometimes towards the violet and sometimes towards the red. They

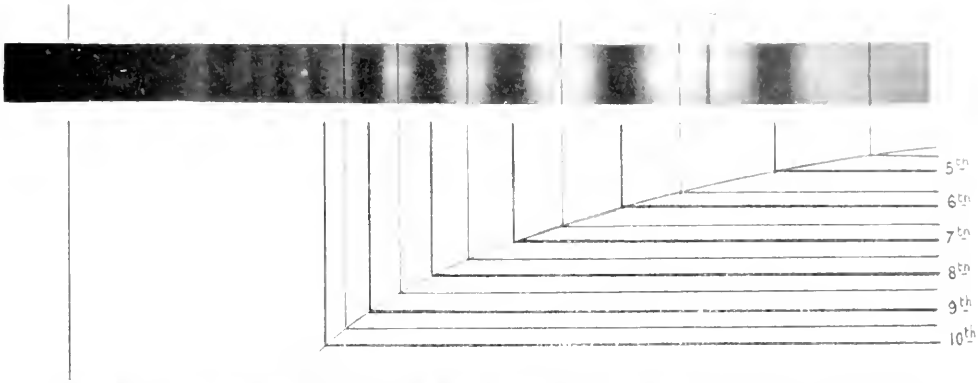


FIGURE 51. Diagram to show the relation of the new Pickering series of Hydrogen to the ordinary diffused series. Shown on the ordinate by thick and thin lines. Some only of the intermediate wave lengths are shown and the horizontal distances are taken twice as far apart as in Figure 52 to show the curve more plainly.

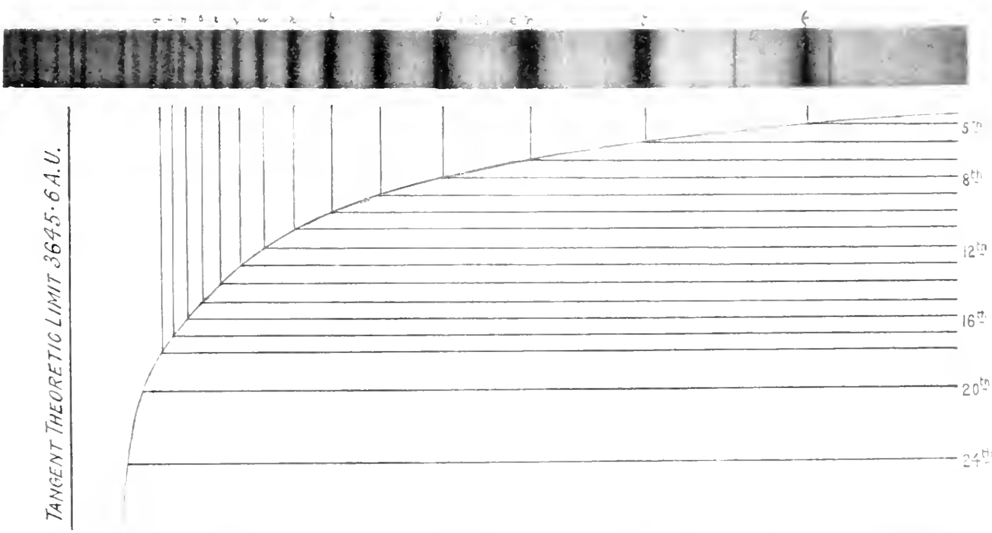
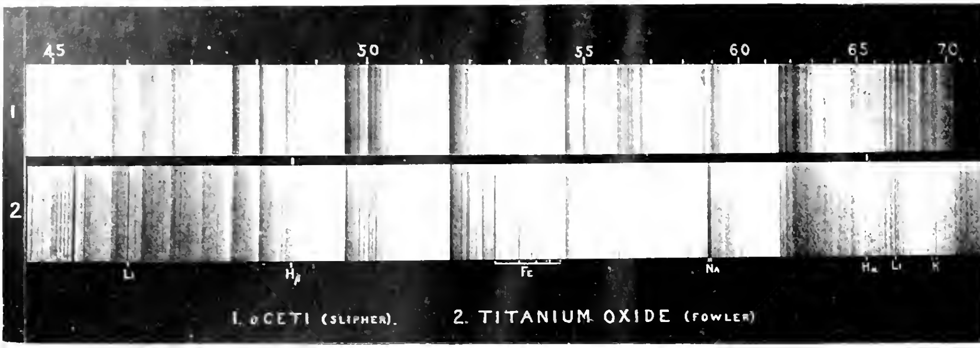
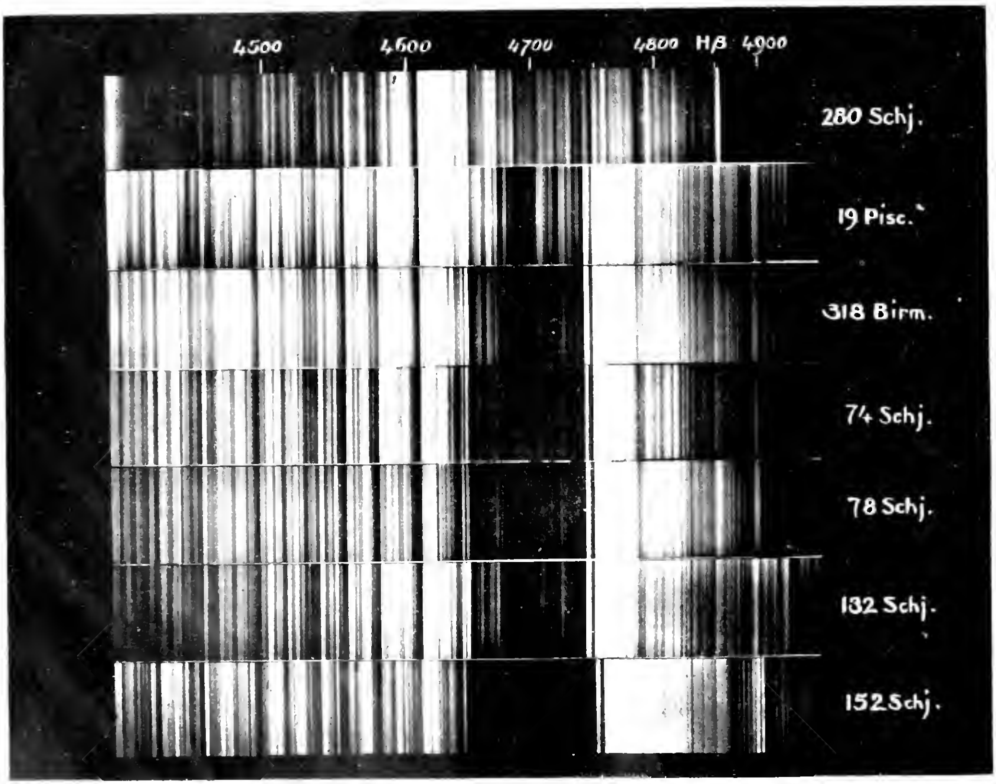


FIGURE 52. Graphic representation of Balmer's Formula showing up to the 24th line of Hydrogen diffused series.


45
50
55
60
65
70
1
2
Li
Hβ
Fe
Na
Hα
Li
K
1. o CETI (SLIPHER). 2. TITANIUM OXIDE (FOWLER)


4500
4600
4700
4800
Hβ
4900
280 Schj.
19 Pisc.
318 Birm.
74 Schj.
78 Schj.
132 Schj.
152 Schj.

are towards the red in titanium oxide, in the variable star o Ceti (Mira) (see Figure 53) and many other variables, also in third-type stars. In Figure 51 the flutings of fourth-type stars are seen to shade the opposite way, and the same is the case with carbon compounds.

The Pickering Series of Hydrogen Lines.

Pickering, in the star ζ Puppis, found a series of sharp lines intermediate between each of the diffused hydrogen lines; as this relation was very striking he thought they might belong to hydrogen also. It was found, if between 3 and 4 and between 4 and 5 we interposed the fractions 3·5, 4·5, and continued this throughout the series, we had the Pickering series.

If we adopt the graphic method we have used, and put in thin lines for the Pickering series, we shall understand the relation of the two series. We first draw thin horizontal lines midway between the thick horizontal lines, and where these meet our curve draw thin vertical lines; we have then the exact position of the Pickering series (see Figure 51). Laboratory experiments afterwards made on hydrogen succeeded in getting these thin lines from hydrogen.

Order in the Spectra of Other Elements.

After the order found in hydrogen was discovered, similar-looking, crowding, faint heads were noticed in the spectra of other elements. The alkalies, lithium, sodium, and potassium, were disentangled, and found to consist of three series. Two of these series were like hydrogen, in that these two series of lines were found to have the same head; and also like hydrogen in that one series was sharp and the other diffused. But these were not the most noticeable lines; another series of more emphatic lines had a head of its own further towards the violet: this was called the principal series.

On plotting all these on curves a relation was seen to exist between them. Using the same relation on hydrogen, and looking for the corresponding lines, a number of hitherto unknown stellar lines were found to correspond with these theoretical lines, particularly a bright blue line in a peculiar kind of star, called Wolf-Rayet stars, so called because Wolf and Rayet noticed a spectrum of mixed bright and dark hydrogen lines in certain stars; afterwards Copeland found many more of them. In these stars all these series of hydrogen lines are found: the principal, the diffused, and the sharp. Some of the lines are bright and some are dark.

When we have studied stellar spectroscopy in its relation to the results of "Partial Impact" we shall have many interesting things to say of the remarkable "Wolf-Rayet Stars."

Since finding the principal series of hydrogen lines, some lines in nebulae and in the Sun, formerly of unknown origin, are now known to be from this principal series of hydrogen. This is the remarkable way in which facts, when correlated, and even more so when associated with theories, lead to the discovery of new facts and the correlation of other facts. Yet so have generalisations been neglected that an eminent solar physicist a year or so ago somewhat angrily told me he did not want to have anything to do with theories—he was looking for facts.

Helium and the Cosmic Pioneer.

But these correlations are only the beginning of this fairy tale of fact. The element Helium was first found in and named after the Sun, and then found in clevite and other minerals, and now found literally everywhere. This element, with its atoms deficient in some of their negative electrons and consequently charged with positive electricity, are the so-called alpha particles that are eternally shooting out of very heavy elements with a velocity sometimes of ten thousands of miles a second. The high velocity of these atoms is the principal origin of the energy of Radium. Helium has a spectrum of extreme complexity.

On looking for heads in order to disentangle its spectrum four were found, two of principal lines and two other heads, each of which had two series, the diffused and sharp, each pair of diffused and sharp having the same finish as is the case in hydrogen and the alkalies. This curious double character suggests to some that it is an element made up of two atoms, although other views are possible. Helium is the lightest of a series of elements of very singular properties. Their names are: Helium, Neon, Argon, Zenon, Cripton. These elements form one of the Mendelief series.

They are all quite neutral, absolute bachelors of the elements. They form no compound at all, and even their molecules are separate atoms. The only uses I have been able to see for them is that perhaps they all help in the building of other atoms, and also aid in the formation of primordial cosmic systems. The origin of these systems I traced out thirty-five years ago, and called "Cosmic Systems of the First Order": remnants of such a system Kapteyn has now found in the Galaxy. This series of neutral elements that I have named "Cosmic Pioneers" stands between the series of halogens, the most negative of all elements, and the alkalies, the most positive of all elements; so it looks somewhat as though Helium might be made up of a very light positive element and a very light negative element, the pair so very strongly joined by their opposite properties as to be inseparable. The higher atomic weight a negative element of a series has, the stronger it is, and the lighter a positive element of a series is, the weaker it is; so Helium may be built up of a very strong negative, so strongly grasping a positive element that to our power of analysis they are an inseparable pair; but this suggestion seems to leave Helium negative. Anyway, whatever is the structure of the Helium atom, the above is a

description of the character of the complex lines of its spectrum; in many of the elements the series, instead of being made up of single lines, consists of double lines, as in sodium; of triple, as the alkalies earths. The lighter the atom is in its series the closer are its lines; so that the pairs in the case of potassium are far apart. In sodium a wide slit makes one of the two, and with lithium it is very difficult to separate them.

Advances in the science of spectroscopy are now so rapid, and there is also growing up so much correlation between astronomy and the experimental sciences, that we have reason to hope that many more of the difficulties that still remain will soon be disentangled.

ECONOMICS AT THE BRITISH ASSOCIATION, 1913.

THE address of the sectional president, the Rev. Philip H. Wicksteed, M.A., was entitled "The Scope and Method of Political Economy in the Light of the 'Marginal' Theory of Distribution." The "marginal" theory of distribution rests upon what may be called "the differential theory of exchange." This theory, in Mr. Wicksteed's words, "regards value in exchange as the first derived or 'differential' function of value in use; which is only as much as to say, in ordinary language, that what a man will give for anything sooner than go without it is determined by a comparison of the *difference* which he conceives its possession will make to him compared with the difference that anything he gives for it or could have had instead of it will or would make." This "differential" attitude, Mr. Wicksteed points out, underlies the whole of human conduct, not only that which may be technically termed "economic": we are always considering the differences in the worth or significance of alternatives, and not the absolute worth or significance of things. He maintains that economics has no special laws of its own, but deals rather with special applications of quite general laws concerning human conduct. His address contained, on the basis of the above theory, an interesting criticism of supply and demand curve diagrams, which diagrams he regards as essentially misleading. Mr. Wicksteed asks economists carefully to examine the basis of their theories, to widen and broaden their concepts, that a body of accepted economic doctrine may be established on a scientific basis, and be available for use by social reformers and legislators.

There was some interesting discussion on the subject of canals and waterways in England. Mr. W. M. Acworth, in a paper entitled "A Forward Canal Policy: Its Economic Justification," argued that "the adoption of a forward policy cannot be justified as in the interest of the community at large," on the ground that railways are economically superior to canals as a means of transport. I must confess, however, that I have more sympathy with the progressive policy of Lord Shuttleworth. No doubt railways possess economic advantages over canals, but that is no argument against the improvement of existing canals as auxiliaries to the alternative means of transport. Lord Shuttleworth's paper was entitled "The Improvement and Unification of English Waterways." He advocates: (1) The formation of "a Central Waterway Board to deal with waterways, much as the Road Board deals with roads, without undertaking the business of carrying"; (2) unification; and (3) improvement of one or two of the main routes as a commencement. A similar policy was advocated by Sir John Purser Griffith, M.Inst.C.E., in his paper entitled "Some Reasons why the State should Improve the Canals and Waterways of the United Kingdom." Mr. Frank R. Durham, A.M.Inst.C.E., contributed a paper on "The Waterways of France, Belgium, and Germany."

H. STANLEY REDGROVE, B.Sc. (Lond.) F.C.S.

ELIZABETHAN BOTANY.

THOSE whose acquaintance with botanical literature is limited to the terse but comprehensive descriptions of Bentham and his fellow systematists would receive a rude shock on turning to the writings of the older school of botanists, or pre-botanists, who flourished three hundred years or more ago. The whole subject has changed since those days; the point of view has been profoundly modified. For while the old herbalists had but scant respect for a plant that possessed no healing or remedial virtues, real or fancied, the modern botanist is content to observe points of structure and harmonies of function, and to discover the relation in which the individual plant stands to the totality of living things. "Utility" as the be-all and end-all of research has given place to the observation of fact and the investigation of "law" in this as in other branches of science.

Written chiefly with a view to extolling the medicinal virtues of plants, a strong family likeness runs through all the old herbals, whether the work of the ancient writers Hippocrates, Pliny, and Dioscorides, or of the more recent mediaeval writers. Moreover these old worthies copied shockingly from one another, sometimes with acknowledgment and sometimes without. Pliny is often referred to as the authority for some particular statement, and his views were always treated with the greatest respect by the herbalists of the sixteenth and seventeenth centuries. Unfortunately there is evidence that the acknowledgment in this case does not always spring from a desire to give credit where credit is due. Thus Culpeper, after quoting the classic writer in connection with the name "anemone" (wind-flower), naïvely adds, "Pliny is my author; if it be not so, blame him."

This same Culpeper, who lived long before the days of shorthand and the typewriter, adopted an original, if somewhat drastic, method of curtailing his literary labours. If the plant under review happens to be of wide distribution, and generally plentiful, it is dismissed with a few words drawing attention to its commonness and couched in terms that have a decidedly quaint and piquant ring to twentieth-century ears. For instance, he soon tires of the numerous family of buttercups. Some are described in detail, while for the rest the reader is reminded that "unless you turn your head into a hedge you cannot but see them as you walk"—doubtless an accurate, though scarcely an illuminating statement. In vain do we seek enlightenment from this celebrated herbalist concerning the tansy, which is referred to as "so well known that it needeth no description." The same remark is made in connection with the stinging nettle, together with the pleasant reminder that "they may be found by feeling in the darkest night." On such terms as these authorship must indeed have been a pleasure.

H. JOHN GRAY.

GRAVITATION.

By J. E. CAIRNS, B.Sc.

NEWTON may be called the Father of Physics. His discoveries in mechanics, light, and pure mathematics are the foundations of our modern knowledge on these subjects. He gave us the laws of motion, and we have evolved from them our splendid system of dynamics; he gave us the explanation of the prismatic spectrum in terms of the different refrangibilities of light of different colour, and to-day we have the spectroscope: his theory of fluxions is the basis of our higher mathematics, and were it not for the unfortunate notation he employed, which made us turn to Leibnitz for a better one, the honour of giving mathematics the trend which it still follows would have been his alone. In all the main branches of physics—with the exception of electricity—Newton gave us the start, and we have followed his leading.

Yet the greatest work of his life we have left just as he gave it to us. We know to-day no more about gravitation than the bare law which he expounded: every particle of matter attracts every other with a force directly proportional to the masses involved and inversely proportional to the square of the distance between them. That is all we know about it, and that is as much as Newton himself knew two hundred years ago.

It is remarkable that we should have extended and improved the lesser discoveries so wonderfully while we allowed the greatest achievement of all to lie uncultivated and neglected. It is remarkable and hard to understand; for if from the study of Newton's prism we have learnt the composition of the stars, and have formulated theories of universal inorganic evolution; and if from the extension of his laws of motion we have learnt to discover unseen planets; then from a comparable extension of his noblest work, his law of gravitation, what altogether stupendous results might we not expect. It is strange that men were not spurred on by such a thought. Strange, but a fact!

No theory of gravitation has ever been seriously formulated. We cannot think of Le Sage's theory except as a working hypothesis which does not profess to explain the matter, but only to aid our thinking about it. To conceive of gravitation as the push of multitudinous, ubiquitous particles flying in all directions is not physically justifiable; for then two bodies would tend to approach each other with a force which varied, not as their masses, but as the difference of their surfaces, and not in any wise as the inverse square of the distance between them. We must dismiss this theory, then, as being a very inadequate attempt to explain the phenomenon; and having done so we have no other to fall back upon. It would seem as though physicists were afraid of the subject. Their treatment of it would lead one to think they regarded it with religious awe, as something final, not to be discussed or investigated.

Why, we may well ask, should gravitation have this cestus of unapproachableness placed about it? There is nothing in itself to demarcate it so rigorously from other objects of physical interest. It is a form of energy comparable in its manifestations with magnetism and electricity. These have been studied closely and carefully; that has been left alone. Why, we cannot understand.

Between two bodies of masses M and m at a distance d apart, the force of gravitational attraction varies as $\frac{Mm}{d^2}$; between two electric charges of magnitudes E and e at a distance d apart, the force of electrical attraction varies as $\frac{Ee}{d^2}$; between two magnetic poles of strengths P and p at a distance d apart, the force of magnetic attraction varies as $\frac{Pp}{d^2}$. In these formulae we see the close analogy between gravitational, electrical, and magnetic force: $\frac{Mm}{d^2}$, $\frac{Ee}{d^2}$, $\frac{Pp}{d^2}$. Each force varies directly as one quantity—mass, electric charge, or pole strength—and inversely as the square of another, in every case the distance, thus showing the *radiant* nature of the energy involved. The formulae seem to indicate an analogy between mass, electric charge, and magnetic strength, and in these days when mass is looked upon as a mode of electrical manifestation the analogy may become a pole-star of discovery. It is not unthinkable that gravitation may be the electrical attraction between electrons, as ordinary electrostatic attraction is the attraction between molar masses; that the one may be the attraction of the electricity inside the atom—which *is* the atom—as the other is the attraction of the electricity on the surface of the atom.

We think of electrostatic attraction as being due to strain set up in the dielectric, and we can think of gravitation only in terms of strain in the ether. The cause and the nature of this strain are difficult to comprehend, but considerations of energy may lead us to some first notions.

Since gravitation is a form of energy its production must be due to a transformation of energy in some other form; and the only possible energy which is competent to result in gravitation is the energy of motion of the electron. The cause must lie in matter itself, and must be independent of the nature of matter—solid, liquid, or gaseous. The only entity that we know of as remaining unchanged throughout all material metamorphoses is the electron, and so to the motion of this we must ascribe gravitation. We cannot give this place of dignity to the atom; for we must believe that the motions of atoms are different in compounds from what they are in the elemental state; and hence their gravitational effect would be different, which is not so. Thus we can provisionally trace the cause of gravitation to electronic vibration.

Now light is due to electronic vibration. We might expect, then, that light and gravitation would exhibit some elements in common, and we find they have at least one. They both vary inversely as the square of the distance. This property is the sign-manual of vibrational disturbances, and on it we can justifiably base a belief that gravitation is a phenomenon of ethereal vibrations as much as light is. Thus we are led to the conception that the ether under the influence of gravitation and the dielectric in the neighbourhood of a charged conductor are in a state, not of static strain, but of kinetic vibration.

We cannot see very clearly how these vibrations can produce attraction; but then we are not able to see clearly how attraction can be produced at all, though we know it is produced. So we must not stop for that.

A question that arises is: If gravitation is of the same nature as light, can its waves be reflected and refracted and polarised like light-waves? Possibly they can; but the fact has never been demonstrated. The practical obstacles in the way of such an investigation are enormous and at present insuperable; for the instruments we must use are themselves gravitative, emitting these hypothetical gravitation-waves; and so the issue of any experiment on the properties of the waves would be so confused as to be undecipherable. What could we learn of the laws of optics if our mirrors and our prisms and our screens and the walls and tables of our laboratories were themselves luminous? In order to study light we must be able to produce darkness

at will, and in order to study gravitation we must be able to secure the absence of it when and where we please. That is at present impossible, but perhaps it will not always be so.

A more fruitful line of thought for the present is, that if gravitation is due to the vibration of electrons its intensity should vary with temperature; that is to say, a body should be heavier when hot than when cold, because of the more energetic vibrations of the electrons. This, it is true, has never been observed to be the case; but we must bear in mind that the absolute value of the gravitative force is very small. We require the pull of a world to make its relative value considerable. Hence any small change which might occur in a piece of matter when heated could not be observed by our instruments. Clerk-Maxwell declared it was possible to detect a difference in weight of one part in five million. If, then, we fail to detect any alteration in the weight of a mass of five poundals (two and a half ounces), we must conclude the change in intensity of the force is less than one millionth of a poundal—an excessively small quantity. Whether the change *should* be observable or not we cannot say, as we know neither the comparative rates of vibration of electrons at different temperatures, nor the relation between intensity of gravitational force and rate of electronic vibration. Such experiments are worth doing again, using larger masses and greater ranges of temperature.

Much may perhaps be learnt by applying such considerations to a charged conductor. Here we have added electrons vibrating on the outside of the conductor, and setting up ethereal disturbances not dissimilar from the gravitative vibrations. It should be a simpler matter to test these for reflection and refraction and other phenomena of vibrational motion, and so obtain a true notion of the nature of dielectric strain. What was learnt in this field might be applicable to the other and more obscure one.

However all this may be, it is clear that the investigation of the nature of gravitation offers no greater theoretical difficulty than that of the nature of electrostatic attraction, and once again its neglect is incomprehensible. The similarity between the modes of action of the two phenomena shows there is an essential similarity between the phenomena themselves. Understanding one we should understand both.

It seems likely, then, that it is the student of electrostatics—a subject somewhat eclipsed nowadays by cathode rays and electrons—who will solve the problem of the balance of the rolling suns and stars and fittingly crown the inheritance which Newton left to us.

OROBANCHES.

By H. STUART THOMPSON, F.L.S.

Perhaps none of the parasitic Orobanches, or Broom-rapes, are more variable or more locally abundant than the handsome *O. speciosa*. Few are more beautiful and at the same time more damaging to crops, particularly to peas, beans, and vetches, in the South of France, Italy, and Spain. Other species in certain countries do great damage also to crops of clover, lucerne, tobacco, hemp and so on.

Broom-rapes are so well known in England that it is hardly necessary to state that they are fleshy, leafless plants, deprived of chlorophyll, or green colouring matter, and often of a brownish colour, which live on the roots of a great variety of flowering plants, but especially upon many kinds of Leguminosae. The word "Orobanche" is derived from the Greek ὄροβος, vetch, and ἄγχω, to strangle. There is an illustrated monograph of the genus in German by Beck. The family to which they belong (Orobanchaceae) comprises the Tooth-wort, which grows on the roots of Hazel, and the curious purple-flowered *Lathraea clandestina*, which attacks the roots of Poplar and other trees in the west of France, Spain, and Italy (It can be seen growing at the foot of a tree in the famous York nurseries of Messrs Jas. Backhouse & Son.) A closely allied family is Scrophulariaceae, to which various semi-parasitic plants belong, such as *Euphrasia* (Eyebright), *Melampyrum* (Cow-wheat), and *Rhinanthus* (Yellow-rattle).

In Britain there are about ten species of Orobanche, but in France we find three times as many, and at least one hundred are known all together. They chiefly inhabit Southern Europe and Western Asia. *O. speciosa* in its distribution is fairly typical of the genus, for it occurs in Provence, Languedoc, Corsica, and a great part of the Mediterranean region.

In the neighbourhood of Carqueiranne, in the Var, France, in May, *O. speciosa* is often seen in enormous quantities in fields of peas, and also among beans and vetches. Very little appears to be done to rid the district of the pest. The flowering spikes should be cut off before they seed, for the seeds are extremely numerous, and they are known to retain their power of germination for several years in the soil. The spikes are from one to two and a half feet high and very handsome. The stout glandular stem is reddish-brown, yellowish or purple according to the colour of the flowers, which are usually white, more or less streaked with violet. Not infrequently, however, they are purple-brown, or sometimes a pale yellow. The stigmas are usually a reddish-violet, but in yellow and sometimes in white specimens they are orange. The corolla is straighter than in most species, and the large lobes are beautifully crenate, the broad lowest one especially. The hairy sepals are deeply bifid, and about as long as the corolla-tube; while the narrow subulate bracts are longer. After being kept in water a week the blossoms appear to become strangely clammy to the touch, and the water is rendered very foul in a few days.

In the department of the Var, where a score of species of Orobanche and eight kinds of Phelipaea occur, *O. speciosa* even attacks Geraniums and Pelargoniums. On Mont Coudon, a limestone mass near Toulon, *O. minor*, a common British species, has been seen by my friend Monsieur Emile Jahandiez on Evergreen Oak. Few varieties attack trees except *O. laurina* in Italy, and near Pisa *O. Yuccae* can be seen on the Mexican *Yucca aloefolia*.

Certain kinds of Orobanche and Phelipaea, a very closely allied genus, produce subterranean cleistogamous flowers, whose seeds ripen and germinate at a depth of a foot or more. One of these is *Phelipaea lutea* of North Africa, employed in Egypt for colouring textile fabric made of the plant called *Hyphaene thebaica*.

It does not seem to be known whether certain kinds of Broom-rape are annual or perennial, nor how long the seeds of many take to germinate; but in 1854 A. Passy sowed seeds of *O. Hederae*, which is occasionally found on ivy in England, which took four years to germinate.

In a field of Narcissus near Carqueiranne, with a few Poppies near, I found an Orobanche which I have been unable to determine, and whether any species is known to be parasitic upon Narcissus I am unaware. The plants were two feet high, the stems very thick and red, and the flowers small, erect, and red.

THE FACE OF THE SKY FOR MARCH.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 7.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Mar. 4	22 57·0	S. 6·7	4 7·[illegible]	N. 26·3	23 3[illegible]	N. [illegible]	23 18·6	S. 6·[illegible]	6 34·[illegible]	N. 26·[illegible]	20 45·7	S. 18·3	4 41·2	N. 20·8	7 5[illegible]	N. 20·6
,, 9	23 16·2	4·7	8 57·[illegible]	N. [illegible]	23 15·[illegible]	S. [illegible]	23 41·5	[illegible]	6 4[illegible]	26·1	20 53·1	18·0	4 42·[illegible]	20·8	7 5[illegible]	20·6
,, 14	23 34·6	2·8	13 30·7	S. 1[illegible]·2	23 [illegible]·1	[illegible]	0 4·3	S. 1·0	6 45·9	25·9	20 57·[illegible]	17·7	4 43·1	20·9	7 49·9	[illegible]
,, 19	23 52·[illegible]	S. 0·8	18 23·[illegible]	S. 28·[illegible]	22 [illegible]	5·2	0 27·0	N. 1·[illegible]	6 52·5	25·7	21 1·4	17·5	4 44·4	20·9	7 49·7	20·6
,, 24	0 11·0	N. 1·2	22 41·4	S. [illegible]	22 4[illegible]	6·8	0 49·7	4·1	6 59·[illegible]	25·4	21 5·[illegible]	17·2	4 45·8	21·0	7 49·5	20·6
,, 29	0 29·2	N. 3·2	2 15·0	N. 18·0	22 55·5	S. 7·[illegible]	1 12·5	N. 6·6	7 7·8	N. 25·1	21 9·1	16·9	4 47·4	N. 21·1	7 49·3	N. 20·6

TABLE 8.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	h. m.	°	°	°	°	h. m.	h. m.
Mar. 4	−22·2	−7·2	132·2	−10·5	−21·4	+2·5	24[illegible]·0	0 59 *e*	−17·4	−0·5	257·5	26·9	2 43 *e*	9 11 *e*
,, 9	23·4	7·2	66·3	+14·0	20·8	3·1	290·0	4 11 *e*	17·8	0·5	320·1	57·4	3 5 *m*	0 29 *m*
,, 14	24·4	7·2	[illegible]·4	+20·4	20·[illegible]	[illegible]	2[illegible]2·2	7 23 *e*	18·1	0·4	24·9	88·0	8 53 *e*	7 30 *e*
,, 19	25·1	7·0	294·5	−2·3	19·2	4·[illegible]	2[illegible]5·2	10 36 *e*	18·4	0·4	103·6	118·6	9 10 *m*	8 43 *m*
,, 24	25·7	6·9	228·6	−20·5	18·3	5·3	1[illegible]8·[illegible]	1 11 *m*	18·7	0·3	17[illegible]·4	149·2	5 7 *e*	5 48 *e*
,, 29	−26·1	−6·6	162·7	−18·4	−17·3	+6·1	110·8	4 25 *m*	−19·0	−0·3	241·3	180·0	3 14 *e*	4 57 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II. to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}8$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN continues its Northward March at its maximum speed. Its semi-diameter diminishes from 16′ 10″ to 16′ 2″. Sunrise changes from $6^h\ 50^m$ to $5^h\ 42^m$; sunset from $5^h\ 35^m$ to $6^h\ 28^m$. The Sun crosses the Equator March 21st $11^h m$, when spring commences.

MERCURY is an evening star till the 9th, then a morning star. Semi-diameter 5″. Illumination diminishes from $\frac{1}{4}$ to zero, then increases to $\frac{1}{3}$. It is $6\frac{1}{2}°$ N. of Venus on 6th.

VENUS is an evening star, but still too near the Sun for convenient observation. Disc practically full. Semi-diameter 5″. Superior conjunction was on February 11th.

THE MOON.—First Quarter $5^d\ 5^h\ 3^m$ *m*; Full $12^d\ 4^h\ 18^m$ *m*. Last Quarter $18^d\ 7^h\ 39^m$ *e*. New $26^d\ 6^h\ 9^m$ *e*. Perigee $12^d\ 10^h$ *e*. Apogee $27^d\ 4^h$ *e*. semi-diameter 16′ 43″, 14′ 43″ respectively. Maximum Librations, 5^d 7° S, 6^d 8° E, 17^d 7° N, 19^d 7° W, Apr. 1^d 7° S. The letters indicate the region of the Moon' slimb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 10.)

MARS is slowly advancing. It is about 8° West of Pollux at the end of the month. It will be seen that both hemispheres of Mars are observable, but the Northern one is best placed. The semi-diameter during March diminishes from 5″ to 4″. The unilluminated lune is on the East: its width increases from $\frac{4}{10}''$ to $\frac{5}{10}''$.

JUPITER is still badly placed, having been in conjunction with the Sun on January 20th. It is a morning star. Polar semi-diameter, $15\frac{1}{2}''$.

Configuration of satellites at $5^h\ 30^m m$ for an inverting telescope.

TABLE 9.

Day.	West.		East.		Day.	West.		East.	
Mar. 1	43	○	21		Mar. 17	432	○	1	
,, 2	431	○	2		,, 18	42	○		31 ●
,, 3	432	⊙			,, 19	41	○	23	
,, 4	42	○	3 1		,, 20	4	○	123	
,, 5	1	○	23	4 ●	,, 21	421	○	3	
,, 6		○	2143		,, 22	234	○	1	
,, 7	21	○	34		,, 23	31	○	24	
,, 8	3	○	14	2 ●	,, 24	3	⊙	14	
,, 9	31	○	24		,, 25	231	○	4	
,, 10	32	○	14		,, 26		⊙	234	
,, 11	2	○	14	3 ●	,, 27		○	1234	
,, 12	1	○	234		,, 28	21	○	34	
,, 13		○	1243		,, 29	2	⊙	14	
,, 14	214	○	3		,, 30	31	○	42	
,, 15	43	○	1	2 ●	,, 31	34	○	21	
,, 16	431	○	2						

The following satellite phenomena are visible at Greenwich, all in the morning hours, $3^d\ 5^h\ 53^m\ 15^s$ I. Tr. E.; $10^d\ 5^h\ 36^m\ 44^s$ I. Tr. I.; $15^d\ 5^h\ 25^m\ 45^s$ II. Ec. D.; $18^d\ 5^h\ 21^m\ 18^s$ III. Ec. D.; $24^d\ 5^h\ 7^m\ 29^s$ II. Sh. E.; $25^d\ 5^h\ 44^m\ 25^s$ I. Ec. D.; $26^d\ 5^h\ 21^m\ 5^s$ I. Sh. E.; $31^d\ 4^h\ 50^m\ 22^s$ II. Sh. I. Attention may be called to the fact that Professor R. A. Sampson's new tables of

Jupiter's satellites are used for the first time in the Nautical Almanac: we may expect a considerable increase of accuracy in the predictions.

The eclipses will take place to the left of the disc in an inverting telescope, taking the direction of the belts as horizontal. Satellites 1, 2, and 4 will all be close together on the morning of the 13th.

$1^d\ 2^h{\cdot}1m$, $9^d\ 7^h{\cdot}2m$, $17^d\ 0^h{\cdot}3e$, $25^d\ 5^h{\cdot}5e$; Rhea (every second given), $6^d\ 8^h{\cdot}6m$, $15^d\ 9^h{\cdot}6m$, $24^d\ 10^h{\cdot}7m$. For Titan and Iapetus E.W. mean East and West Elongations; I. Inferior (North) Conjunctions, S. Superior (South) ones. Titan, $1^d\ 9^h{\cdot}9e$ S., $6^d\ 0^h{\cdot}6m$ E., $10^d\ 0^h{\cdot}6m$ I., $13^d\ 9^h{\cdot}7e$ W., $17^d\ 9^h{\cdot}6e$ S., $22^d\ 0^h{\cdot}6m$ E., $26^d\ 0^h{\cdot}4m$ I., $29^d\ 9^h{\cdot}3e$ W: Iapetus, $6^d\ 5^h{\cdot}0m$ E., $27^d\ 1^h{\cdot}2m$ I.

TABLE 10. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. to E.	Time.	Angle from N. to E.
1914			h. m.		h. m.	
Mar. 2	μ Arietis	5·7	4 41 *e*	81°	5 59 *e*	220°
„ 3	16 Tauri	5·4	11 49 *e*	121	0 32* *m*	225
„ 3	19 Tauri	4·3	11 56 *e*	80	0 49* *m*	265
„ 4	20 Tauri	4·1	0 13 *m*	108	1 0 *m*	238
„ 4	21 Tauri	5·8	0 16 *m*	65	1 6 *m*	281
„ 4	22 Tauri	6·5	0 18 *m*	72	1 10 *m*	274
„ 4	BD+24°562	7·0	0 40 *m*	81	—	—
„ 4	BD+26°731	7·0	11 52 *e*	75	—	—
„ 5	BAC 1648	6·4	4 8 *e*	96	5 25 *e*	246
„ 7	BD+27°1164	6·9	0 54 *m*	135	—	—
„ 7	Wash. 466	7·7	2 55 *m*	120	—	—
„ 8	κ Geminorum	3·6	4 29 *m*	162	4 55 *m*	231
„ 9	Wash. 635	6·6	5 55 *e*	186	—	—
„ 10	BD+11°2217	7·0	10 35 *e*	114	—	—
„ 11	45 Leonis	5·8	1 0 *m*	158	1 54 *m*	273
„ 11	ρ Leonis	3·8	3 30 *m*	81	4 12 *m*	341
„ 11	49 Leonis	5·7	4 46 *m*	142	5 34 *m*	276
„ 12	Wash. 780	6·9	—	—	11 5 *e*	278
„ 14	BD−11°3460	7·0	—	—	4 45 *m*	316
„ 17	Stone 8802	7·0	—	—	3 43 *m*	351

The asterisk indicates the day following that given in the date column.

From New Moon to Full disappearances occur at the Dark Limb, from Full to New reappearances.

Attention is called to the occultation of the Pleiades on March 3rd–4th. Alcyone will escape occultation on this occasion.

SATURN is in quadrature on 2nd, some 5″ N.E. of Aldebaran. Polar semi-diameter 8″. P. is −4°·2; B −26°·6. Ring major axis 42″, minor 19″. The ring is approaching its maximum opening, and projects beyond the poles of the planet. It is interesting to measure the exact amount of overlap. The absolute maximum opening will occur on June 1st, but the Planet will then be too near the Sun to see.

East Elongations of Tethys (every fourth given), $3^d\ 9^h{\cdot}9e$, $11^d\ 11^h{\cdot}2m$, $19^d\ 0^h{\cdot}5m$, $26^d\ 1^h{\cdot}8e$; Dione (every third given),

URANUS is invisible, having been in conjunction with the Sun on January 28th. Very near Jupiter on 4th, $9^h m$.

NEPTUNE was in opposition on January 17th. Semi-diameter 1″. Possessors of small telescopes may easily recognise it by its motion, if they make a sketch map of the stars in the region, and observe it night by night.

ECLIPSE OF THE MOON on morning of March 12th, visible in British Isles. First contact with shadow $2^h\ 42^m m$, angle

TABLE 11. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
U Urs. Maj.	10 9	+60·4	6·0 to 6·5	irregular	
U Hydrae	10 33	−12·9	4·8 to 6·7	irregular	
R Urs. Maj.	10 39	+69·2	5·9 to 13·1	299	May 9.
V Hydrae	10 47	−20·8	6·5 to 7·7	irregular	
S Leonis	11 6	+5·9	9·0 to 13·0	189·5	May 18.
RY Urs. Maj.	11 37	+39·0	8·3 to 14·0	unknown	
S Crateris	11 48	−7·1	8·4 to 9·5	unknown	
Z Urs. Maj.	11 52	+58·4	6·8 to 8·7	irregular	
R Comae	12 0	+19·3	7·3 to 13·5	361·8	June 4.

Principal Minima of β Lyrae Mar. $4^d\ 11^h\ 50^m e$, $17^d\ 9^h\ 56^m e$, $30^d\ 8^h\ 2^m e$. Period $12^d\ 21^h{\cdot}8$.

Algol minima Mar. $2^d\ 3^h\ 36^m e$, $11^d\ 6^h\ 3^m m$, $14^d\ 2^h\ 52^m m$, $16^d\ 11^h\ 41^m e$, $19^d\ 8^h\ 30^m e$, $22^d\ 5^h\ 19^m e$.

Mira Ceti will reach maximum on March 17th, Mag. 2·0; it will, however, be too near the Sun for convenient observation.

88 from N. to E. Greatest eclipse 4^h $13^m m$, magnitude 0·916 (Moon's diameter being 1). Last contact with shadow 5^h $44^m m$, angle 330 from N. to E. Moon sets 6^h $25^m m$. A smoky appearance will be visible on the East portion of the Moon fully 20^m before first contact with shadow.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable. (See Table 11.)

METEOR SHOWERS (from Mr. Denning's List).

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Mar. 1-4	166	4	Slow, bright.
„ 1-14	175	10	Slow.
„ 18	310	76	Slow, bright.
„ 24	161	58	Swift.
„ 27	220	32	Swift, small.
Mar. May	263	62	Rather swift.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE EARTH'S ALBEDO.—The lines of Robert Burns—

O wad some power the giftie gie us
To see oursels as ithers see us—

must have often found an echo in the minds of astronomers. A view of our Earth from external space would, no doubt, be a great help in interpreting the appearances presented by our neighbour worlds, Venus and Mars. There is one method of getting some idea of the Earth's albedo: this is by measuring the intensity of the faint Earth-shine on the crescent Moon, which travels first from Sun to Earth, is reflected from Earth to Moon, whence it is sent back to Earth once more. The difficulties in such a research are manifold. The Earth-shine is blended with the diffused skylight, which arises from the illuminated crescent of the Moon, and the two light sources have to be separated. Further, it is by no means easy to compare the light of the thin lunar crescent with the light of the full Moon, and this is a necessary step in the work. Professor F. W. Very has made a careful research at Westwood Astrophysical Observatory which he describes in *Astron. Nachrichten*, 4696. It would be difficult to summarise his article, so I content myself with quoting his result, which gives an albedo of 0·89 to the Earth. This means that of one hundred rays falling on the Earth (or, rather, on its atmosphere) eighty-nine are reflected back into space, and only eleven absorbed. Since the albedo of the Earth's surface is obviously much lower than this, we conclude that the greater part of the reflection takes place in our upper air, and consequently that comparatively little of the radiant energy that falls on our atmosphere reaches the ground, or is effective in giving us light and heat. Professor Lowell long since explained the rapid melting of the Martian polar cap by the low albedo of that planet and the consequent small absorption in its atmosphere. Hence, in spite of its greater distance from the Sun, the radiant energy that actually reaches its surface may not be very far short of that on the Earth's surface. The cold of the Martian nights must be intense, for the thin atmosphere that presents so slight a screen to incident heat will also present a poor screen against its escape. But the snow cap in summer enjoys perpetual day that lasts for many of our months; and as the white deposit is presumably very shallow, owing to the scarcity of aqueous vapour, its rapid disappearance ceases to be a matter of surprise.

Professor Very quotes in his article the value of the Earth's albedo obtained by MM. Arago and Laugier, viz., 0·6477 for the waxing Moon and 1·132 for the waning one. A value above unity is, of course, impossible, and the large discordance between the two values illustrates the difficulty of the investigation. The mean of the two is 0·89, which agrees exactly with Very's value.

A NEW COMET.—M. Delavan, who found Westphal's Comet, made another discovery in December. It was faint at discovery, but is likely to be an easy telescopic object in February and March. The following elements are by Professor Kobold:

Perihelion	...	1914	March 2·32, Berlin M.T.
Omega	...	7	40′
Node	...	126°	33′
Inclination	...	13	5′
Log q..	...	0·0453	

Ephemeris for 11 p.m.

	R.A. h m s	N.Dec. ° ′	Log r.	Log Δ.
Feb. 5	3 17 50	8 47	0·0717	9·7758
Feb 13	3 35 31	13 42	0·0576	9·7523
Feb. 21	3 58 59	19 12	0·0484	9·7296
Mar. 1	4 29 43	25 8	0·0448	9·7095

It will be seen that the distances from the Sun and Earth are both diminishing, so that the brightness is likely to increase. According to an American orbit, Perihelion will not be reached till June 28th, and there will be a great increase of light.

MOTIONS IN THE LINE OF SIGHT.—The December number of *Publications of the Astronomical Society of the Pacific* contains some interesting determinations of radial velocity of planetary nebulae. The results for fourteen nebulae range from 60 km. approach to 60 km. recession with reference to the stellar system; there are two with very high velocity. The tenth-magnitude planetary nebula N.G.C. 4846 (R.A. 19^h 11^s, S. Dec. 19° 14′) is receding at 150 km. per second from the Sun; N.G.C. 5873 (R.A. 15^h 6^m, S. Dec. 37° 43′) is approaching at 136 km.

There is also a note of a star with an extraordinarily high radial velocity. The star Lalande 1966 (R.A. 1^h 3^m) has a speed of approach of 325 km. It clearly belongs to the class of "Runaway" stars of which Arcturus and Groombridge 1830 are well-known examples. It has a parallax of 0″·08 (Yale) and a spectrum similar to that of Procyon.

THE ELECTRIC-CELL PHOTOMETER.—Professor Campbell has an article on this subject in the same publication. It consists of a glass bulb, part of whose interior surface is coated with an alkaloid metal, such as potassium or sodium; the bulb contains some rarefied gas. Wires of an electric circuit lead respectively to the coated and uncoated portions of the glass. While the cell is dark no current will cross the gap between the terminals. But if a faint light be thrown on the alkaloid surface the rarefied gas becomes a conductor. The strength of the current passing, as measured by an electrometer, determines the intensity of the illumination. The instrument can be used either for obtaining intensity curves of various parts of the spectrum (including perhaps the accurate location of spectral lines) or for determining star magnitudes. It is stated that the magnitude of a fifth-magnitude star can be determined in two minutes to within ·003 magnitude. Mr. Joel Stebbins, who has become famous by his remarkable results with the selenium photometer, is so struck by the superior accuracy of the new method that he is abandoning his former one in order to give it a trial. In view of his skill and

experience we may hope for remarkable results in the study of variable stars.

THE LATE MR. FRANKLIN ADAMS'S PHOTOGRAPHS.—The entire set of these photographs, showing the whole heavens from pole to pole down to magnitude 15, are being reproduced at the Royal Observatory. They are two hundred and six in number, each covering about $16° \times 16°$. Ten plates, showing regions of special interest, have been reproduced in *Memoirs of R.A.S.* (Vol. LX, Part III).

No. I is the large Magellanic cloud, which Mr. Melotte considers to show a spiral structure. The plate brings out the complicated character of the cloud, which contains both clusters and nebulae.

No. II contains α Crucis and η Carinae (with its nebula), and shows remarkable dark lines in the Milky Way. These are also shown in No. III, which shows the startling blackness of the Coal Sack.

No. IV shows our nearest stellar neighbour, α Centauri, which is in a rich region of the Galaxy.

No. VII shows the brightest part of the Galaxy, the star-cloud in Sagittarius and the Trifid nebula. Mr. Melotte says: "The negative shows in the denser parts of the cloud a continuous background of faint stars, the images of which are too close to be separated."

No. X shows the eastern part of Orion, and part of the immense faint spiral nebula that extends from the Great Nebula. A very curious dark bay is shown in the nebula that extends to the south of ζ. All the plates in the Memoir will repay careful study.

SIR D. GILL'S HISTORY OF THE CAPE OBSERVATORY (Third Notice).—The history of our knowledge of the Sun's distance is told in brief in these pages. Passing quickly over early determinations, we come to Newcomb's publication in 1864 of the value $8''\cdot855$ for the parallax from observations of Mars in 1862. This gives a distance only half a million miles less than that now adopted. It is well known that the transits of Venus in 1874 and 1882 proved very disappointing, and left the residual uncertainty as large as ever. The next phase was the heliometer method applied to Mars in 1877 by Gill at Ascension, and subsequently to the three minor planets—Iris, Victoria, and Sappho. Four observatories coöperated in the heliometer work, and twenty-two in meridian observation of the comparison stars. The observations were sufficiently accurate to "beat the seven-figure logarithm table," and new ephemerides with eight figures were computed. The resulting parallax from the three planets was $8''\cdot804$; this is practically identical with Mr. Hinks's value from Eros $8''\cdot807$. The latter is subject to the drawback that, being mainly photographic, there is a possible small error from difference of refraction of Eros and the comparison stars. Probably little further change will be made in the accepted value till the great Eros campaign of 1931, when the planet's distance will be only $\cdot17$. It may be hoped that after that the third decimal in the parallax will be nearly free from doubt.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

CELL-DIMENSIONS IN DWARF PLANTS.—The question whether differences in size between individuals of the same species, or between different varieties, or between the organs of the same individual, are expressed in differences in the size of the cells, has been investigated statistically by H. Sierp (*Jahrb. f. wiss. Bot.*, Band LIII, 1913), with special reference to dwarf plants. The author points out that a sharp distinction must be drawn between dwarf forms, which owe their dwarfing to unfavourable environmental conditions, and true dwarfs. The former attain the normal size when transferred to favourable conditions, and may be distinguished as "pathologically dwarfed" forms, but the true dwarfs do not thus respond to better conditions, and must be regarded as constitutionally dwarfed. Sierp finds that dwarf forms of the first kind invariably have smaller cells than the normal form; in some cases (*e.g.*, the stinging nettle) the cells are only half as large as those of ordinary individuals. Among true dwarf forms there was, however, great variety in the size of the cells as compared with that of the cells in normal-sized individuals. Thus in some dwarf varieties of potato the cells were invariably smaller than in normal varieties, in a dwarf *Mirabilis jalapa* the cells were just about the normal size, while in a dwarf *Nigella* the cells were actually larger than in the normal plant.

SOIL FUNGI AND HUMUS-FORMATION.—In the last number of "KNOWLEDGE" (p. 28) reference was made to the special fungus flora of the soil. Since that note was written we have received a reprint of an interesting paper by Wanda Daszewska (*Univ. de Genève Inst. Bot.*, 1913), giving descriptions and figures of a large number of fungi isolated from peat, including fourteen new species. The previous workers on soil fungi dealt with ordinary field soil and the leaf mould of woods, but very little was known regarding the fungus population of peat, which is apparently considerable though less abundant than that of woodland soil. The authoress made careful experiments in order to ascertain what action these peat fungi had upon cellulose—an interesting point when we remember that cellulose in the form of cell-walls must constitute a large portion of the organic matter which returns to the soil and is converted into humus. It has long been known that certain bacteria are capable of destroying cellulose, and the same applies to a number of fungi; but we now have the results of special experiments made with peat fungi, showing that these fungi in many cases rapidly destroy cellulose, and it would appear that fungi play a far more important part than bacteria in the cellulose decomposition that goes on in the soil. The brown colour of humus is apparently due, in part at any rate, to the actual colour of the mycelium and spores of the fungi, and to brown and black pigments, as well as to oxidising ferments produced by the soil fungi.

DENITRIFYING MARINE BACTERIA.—In an interesting paper Drew (*Journ. Marine Biol. Assoc.*, 1913) describes observations made on the denitrifying (nitrate-destroying) bacteria of temperate and tropical seas, with particular reference to the power which these bacteria apparently have of precipitating calcium carbonate from soluble calcium salts present in sea-water. According to this author, the vast deposits of chalky mud now being formed off the Bahamas and Florida are being precipitated by bacterial agency, which has probably been an important factor in the formation of chalk and various other kinds of sedimentary rock chiefly or in part composed of calcium carbonate. The denitrifying and lime-precipitating bacteria are much more abundant in warm than in cold seas, and this lends strong support to the interesting theory put forward by Brandt in 1904 to account for the fact that despite the more favourable conditions as to light and warmth in warm seas, the latter contain less abundant minute floating forms (plankton) than the colder seas. Brandt suggested that if the denitrifying bacteria of the sea, like those of the land, develop a strongly disturbing activity at higher temperatures, only a relatively small production of plankton would take place in warm seas on account of the deficiency in nitrates, while in colder seas more nitrates would be at the disposal of the plankton owing to the retardation or suppression of the disturbing (denitrifying) process. A point strongly in favour of this theory is that all the denitriying bacteria found in temperate seas have a higher temperature optimum than that of their natural environment; but all attempts so far made to correlate quantitative plankton observations with direct

analysis of the amount of combined nitrogen in sea-water in different localities have failed owing to the difficulty in estimating the nitrate content. However, Drew's observations, until more refined chemical methods can be found for directly testing the matter, appear to form conclusive evidence in favour of Brandt's conjecture.

SEXUAL REPRODUCTION IN YEASTS.—Some years ago it was found that in some of the yeasts (Saccharomycetes), the production of spores is preceded by the conjugation of two cells. This has now been observed in several species, and it strongly supports the view that the yeasts are to be regarded as degenerate forms arising from the Ascomycetes, and not as primitive types of Fungi. This is made still more evident by the fact that in some of the conjugating or sexual yeasts the cells are not simply rounded or ovoid and isolated or united loosely in chains formed by budding, but form a small but definite mycelium. Recently, Konokotina (*Bull. jard. bot. St. Petersburg*, 1913), has described two new species of yeast in which the two cells which conjugate are not alike, as in the conjugating yeasts formerly described, but are differentiated into a large (female) cell and a small (male) cell. One of these heterogamous forms, *Nadsonia elongata*, consists of oval cells which before conjugation become elongated; the two conjugating cells are of different sizes; after conjugation, the female cell sends out a bud-like growth into which pass the fused nuclei and protoplasm, and in this outgrowth the single spore is formed. The second form, *Debaryomyces tyrocola*, is interesting because the conjugating cells may be either alike (homogamous) or unlike (heterogamous) the latter case being the more frequent and showing the same features as in *Nadsonia*.

CHEMISTRY.

By C. Ainsworth Mitchell, B.A. (Oxon), F.I.C.

PAPER DUST EXPLOSION.—*The Times Engineering Supplement* of December 3rd, 1913, gives an account of a paper dust explosion which took place in a factory at Lille last year. The dust was produced during the grinding of the edges of rolls of paper, and the special chamber in which it collected was emptied from time to time. The explosion occurred while this chamber was being emptied. Samples of the dust were tested at the experimental laboratory at Liévin, and were found to be capable of exploding when mixed with air in a closed space and brought into contact with a flame. The dust was as inflammable as finely powdered coal dust containing thirty per cent. of volatile substances. Numerous cases are on record of explosions due to fine carbonaceous dusts, such as those of flour, starch, and sugar, but this appears to have been the first instance in which paper dust has been the cause of an explosion.

MECHANISM OF OXIDATION PROCESSES.—A theory has been put forward by Dr. H. Wieland that the terms "oxidation" and "reduction" are in reality two ways of representing one process of removal of hydrogen, or "dehydrogenation." In support of this view he cites numerous experiments, and shows that even the biological processes attributed to oxidation are also susceptible of the same interpretation (*Ber. d. Chem. Ges.*, 1913, XLVI, 3327). For example, dextrose (glucose) can be decomposed into carbon dioxide by means of palladium black acting at a low temperature in the presence of oxygen or a quinone compound which is capable of absorbing the liberated hydrogen, and thus preventing it combining with the palladium and rendering it inactive.

In like manner the changes effected by the enzymes, known as oxidases, may also be brought about by palladium black in the presence of quinone, or methylene blue; and since, under such conditions, oxygen is excluded the reäctions can only be attributed to processes of dehydrogenation. Alcohol is transformed into acetic acid (vinegar) by the action of specific bacteria, and, as a free supply of atmospheric oxygen is required under the ordinary manufacturing conditions, the process has long been accepted as a typical instance of biological "oxidation." Dr. Wieland, however, shows that the acetic bacteria and the enzyme isolated from them will effect the conversion of alcohol into acetic acid in the presence of methylene blue and in the absence of oxygen.

Again, the reducing enzyme which is present in milk is capable of transforming salicylic aldehyde into salicylic acid in the presence of methylene blue—or, in other words, of acting as an "oxidising" enzyme.

PETROLEUM SPIRIT FROM NATURAL GAS.—The increasing demand for petroleum spirit suitable for the engines of motors has led to numerous attempts to discover fresh sources of supply. During the last three years a large amount of gasoline has been obtained from natural gas in America, and this is employed in admixture with the products from the oil refineries, for lighting and heating purposes, and, to a less extent, as a motor spirit. Its want of homogeneity, however, causes it to give trouble in working, and its commercial success in this respect is therefore still doubtful.

In the last issue of *Petroleum* (1913, IX, 217) an interesting account is given by Dr. Rozanski of the development of this branch of the industry in Galicia. The first attempts to obtain gasoline from natural gas were made there in 1910, when a condensing plant was put up at Humniska. This was capable of treating six hundred cubic metres of gas in twenty-four hours, and yielded a petroleum spirit with a specific gravity 0·660. The yields were too low, however, for profitable working, and, after about a year's experiment, the work was abandoned. For the same reason another plant, erected last year in Carpathia, was also abandoned.

Much of the natural gas emitted from fissures in the oil-fields is unsuitable for cooling and compression, as, for example, the so-called "dry gas," which contains over forty per cent. of methane. The richest American natural gases yield over one hundred litres of gasoline per one hundred cubic metres, the average yield being about forty to forty-six litres. As compared with this the yields from the Galician gases are very low. A natural gas, composed of sixty per cent. of benzine vapours and forty per cent. of methane, yields, in practice, only about fifteen per cent. of the calculated amount of spirit; but at the present time a yield of even five litres per one hundred cubic metres of gas ought to be profitable, provided that the residual gases were used for heating.

To condense the gases they are first compressed at about three and a half atmospheres, and subsequently at pressures of fourteen to forty-two atmospheres. The cooling is effected by water, ammonia refrigerators, or by the sudden expansion of the compressed gas itself. The resulting petroleum spirit is colourless or light brown, and has a specific gravity of about 0·730 to 0·770. Formerly the American product had a specific gravity of 0·650, or less; but that now prepared has about the same specific gravity as the Galician gasoline. The condensed spirit consists principally of butanes and pentanes, with a little propane and a small amount of hexanes, heptanes, and perhaps nonanes.

ENGINEERING AND METALLURGICAL.

By T. Stenhouse, B.Sc., A.R.S.M., F.I.C.

NOMENCLATURE OF NON-FERROUS ALLOYS.—The question of a revised nomenclature of non-ferrous alloys is receiving attention both in this country and in America. Besides the purely trade names there are many anomalies in the existing nomenclature, the present names being often misleading, as indicating the composition of particular alloys. Thus, whilst the term "brass" is universally understood to represent a copper-zinc alloy, and "bronze" a copper-tin alloy, "manganese bronze" is not an alloy of copper, tin, and manganese, but is generally a typical "brass" containing under three per cent. of

manganese. "German silver" is another instance of a misleading name, the components of the alloy being copper, nickel, and zinc. Dr W. Rosenhain, in this country, has made some suggestions to the Institute of Metals towards a revised nomenclature, and in America, Mr. C. P. Karr contributed a paper on the subject to the American Institute of Metals at the annual meeting held at Chicago in October last. Mr. Karr gives an interesting historical survey, and submits a tentative scheme of classification. He also gives examples of present misnomers, which naturally conflict with the suggested names. Now that the two English-speaking representative bodies are interesting themselves in this question no doubt serious efforts will be made towards a modified nomenclature; but it must not be considered that changes will be easily made. It is probable that many buyers of copper alloys who know that they can get the material they require under a particular name will not easily be persuaded that the material with the new name is "just the same."

EGYPTIAN METAL ANTIQUITIES.—The chemical composition and microstructure of some metal articles made by the ancient Egyptians in the earliest times have been determined by Mr. H. Garland (*Institute of Metals*, 1913, Vol. X, page 329). The object in view was to ascertain to what extent such changes as recrystallisation, diffusion, and growth of crystal grains take place in metals and alloys at atmospheric temperatures during long periods. A knife attributed to the eighteenth dynasty, and therefore about three thousand five hundred years old, was composed of impure copper. The microstructure indicated that the knife had been hammered into shape cold from a cast rod. No appreciable diffusion or crystal growth had taken place during its lifetime. An arrow-tip, also of impure copper, had a similar structure to that of the knife. An ancient Egyptian bronze spatula gave indications of having been annealed after being partially worked, and of having been finally worked cold without further heat treatment. The metal had not recrystallised after the cold work, but was apparently in the same state as when it left the makers' hands. A copper dagger attributed to the first dynasty, and therefore some seven thousand years old, gave evidence of a slight amount of hot work having been done on it; but it had never been properly annealed. No appreciable diffusion had occurred during its lifetime, but some recrystallisation had taken place in the arsenic-rich parts. The author considers from his investigations that the structural changes which take place in such metals and alloys at atmospheric temperatures are trifling.

CORROSION OF IRON.—Dr. J. Newton Friend, who has made a special study of the corrosion of iron and steel, describes, in the October number of *Science Progress*, a number of simple and interesting experiments with iron foil in different saline solutions. Experiments are described also which demonstrate the necessity of having sufficiently large vessels, in carrying out investigations on corrosion, to ensure that immersed samples of metal shall be at all points in contact with solution in the same state as regards dissolved oxygen.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

BIOGEOGRAPHY OF THE TSETSE FLY.—We notice in the *Annales de Géographie* of November a very interesting biogeographical study of the tsetse flies found in French West Africa, by E. Roubaud, with photographs illustrative of the types of habitat of the eight species occurring in the area. He works out the ranges of the species, and recognises important definite differences within species determined by climatic differences, particularly by differences of latitude. For example, *Glossina palpalis* follows the virgin forest in its extension from 4° 30′ N. latitude on the Ivory Coast to about 8° N. latitude, infests the wooded terraces which extend behind to 11° and the less-densely forested borders of these in the French Sudan, where, at certain seasons of the year, it may be encountered up to 14°. Its extension inland is therefore through nearly ten degrees of latitude, and on the coast, where more humid conditions obtain, this is increased by two degrees, the northern limit being at the mouth of the Senegal. The range of climate over this area is considerable. Temperature at the Ivory Coast has a mean of 25° and an amplitude of 20° (Centigrade); in the Sudan the mean is 29° and the amplitude 40°, while the humidity is very much lower than at the coast. It is therefore not surprising that there are geographical races within the species, distinguished by darker colour towards the coast. *G. morsitans* varies similarly with geographical position, and some investigators have been induced by the marked differences to distinguish a subspecies. This variation with climate in species having a wide geographical range is shown to have important correlations when the writer goes on to consider the distribution of trypanosomes and *Glossina* in the region, their biogeographical relations, and their influence on the life of West Africa. Trypanosome diseases are shown to be endemic in certain parts. The infectivity of the tsetses is found to be strikingly different in different places. In some parts trypanosome diseases are unknown or very rare; often such cases as are known are imported. And this is believed to be dependent on the climatic control of the physiology of the salivary glands of *Glossina*.

RUSSIAN WHEAT AND THE BLACK SEA PORTS.—The same journal publishes figures concerning the adjustment of the export trade in wheat of the Black Sea ports, the difficulties under which the trade is carried on, and the measures that are being adopted to remove them. In a country where the methods of agriculture are only beginning to grow out of their primitive condition one does not expect to find a highly organised system of transport. The present one is such that much of the country produce does not reach the ports before the winter has set in, with the result that a great deal of it has deteriorated very badly, and the price realised falls enormously. The matter is important in these days when the wheat supply of the world is a matter which is providing material for some thought, and fortunately the Russian Government are taking steps to reduce the waste, while their action is hailed in the country with enthusiasm. Elevators and stores on the American model are under construction in agricultural areas in Europe and Asia, and it is expected that in five years there will be a supply of depots sufficient to relieve the present need for cleaning, fanning, and classifying the grain. Control will be exercised by a special department under the Minister of Finance, and the officials in charge of the stations will act as intermediaries between the producer and the merchant. There is no want in the number or size of the ports which handle the grain, but it is interesting to note that Odessa has lost its pre-eminence in the trade. Last year it came after Nicolaev and Rostov, but the statistics of several years back put it further behind. Wheat, moreover, is by no means the cereal most largely exported. Barley comes first; and oats, maize, and rye are shipped in quantities.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

THE ASCENT OF LAVA.—Why does lava rise from below towards the Earth's surface? The question is raised by F. A. Perrett in a paper on "The Ascent of Lava" (*American Journal of Science*, December, 1913). The initial direction of movement of the lava, as it seeks to spread from the intercrustal reservoir, is, no doubt, determined by the lesser pressures which prevail toward the surface. Its continued ascent, often in a narrow cylindrical tube, is a perplexing problem. As Perrett points out, such upward

progression represents work against gravity, and necessitates the perforation of successive strata. Furthermore, it takes place at the point farthest removed from the heat reservoir and where the actual contact-pressure is least.

In common with Professor R. A. Daly, Mr. Perrett concludes that the chief agent concerned in the upward progression of the lava column is magmatic gas. Every magma is saturated with gas, which, when disengaged, tends to collect at the top of the lava column. In this position it is under enormous pressure, which tends to augment its already great heat, and gives it the power of acting as an efficient fluxing agent. The volcanic pipe is therefore considered to have been drilled by a gas-fluxing process essentially similar to that of an ordinary blowpipe. When the lava eventually attains the surface and initiates a volcano, a further problem arises as to the continuance of the supply of heat necessary to its activity. The whole question of volcanic activity is beset with similar interesting problems, which are being attacked with great energy by such workers as Professor R. A. Daly, A. Brün, and F. A. Perrett.

SATURATED AND UNSATURATED IGNEOUS ROCKS.—Professor S. J. Shand points out and emphasises a distinction in the behaviour and occurrence of igneous rock minerals with respect to free silica (*Geological Magazine*, November, 1913). About half of these are capable of forming in the presence of free silica, and are associated in igneous rocks with quartz and tridymite. The remaining rock-forming minerals do not appear along with quartz, save in certain exceptional cases. The former set are the more highly saturated, the latter the less highly saturated compounds of their respective metallic elements, and are said to be saturated or unsaturated respectively with regard to silica. The saturated minerals have taken up their full complement of silica, whereas the unsaturated have not. Familiar examples are orthoclase and albite amongst the saturated, and leucite and nepheline amongst the unsaturated group.

Professor Shand makes a distinction between igneous rocks according as to whether they are composed of saturated or unsaturated minerals. The groups thus formed correspond largely with those now known as calcic and alkalic. The unsaturated or alkaline rocks have in general a much greater action on the rocks they invade than have the saturated rocks, since they are capable of entering into chemical combination with the silica of the invaded rock masses. As a consequence of the chemical activity of an under-saturated magma a greater variation, both chemical and mineralogical, would be expected in an under-saturated than in a saturated igneous complex. This deduction is confirmed by the well-known variable character of alkaline rocks.

Professor Shand thinks that the distinction may prove of use in classification. It may perhaps be pointed out that it is recognised in the American Quantitative Classification by the ratio which determines the *orders* in that system. This ratio contrasts the amount of quartz *or* lenads (felspathoids) with that of felspars. The rocks falling in the orders determined by the quartz-felspar ratio are the saturated types; those falling in the orders determined by the lenad-felspar ratio are the under-saturated types.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

A WATERSPOUT AT CLOSE RANGE.—Captain H. C. Hansen, of the Norwegian ship "Majorka," on October 2nd, 1913, when in latitude 45° 37′ N. and longitude 14° 0′ W., was fortunate enough to observe a waterspout at close range. He has furnished to the United States Hydrographic Office the following interesting account of its formation.

"At 7.30 a.m. a whirlwind was seen about an eighth of a mile to the leeward of the ship, which was headed north-west, and when it became apparent that it was an incipient waterspout the wheel was put hard to starboard and the ship was gotten off toward the west-south-west, and immediately the whirlwind passed the ship's stern in a north-south direction at a distance of about ten feet. It had taken the form of a thin spout, which increased in diameter and became denser. It was accompanied by a strong puff of wind, a heavy downpour of rain, and roaring sound.

"Within a circle of about twenty-five feet in circumference the water was in a violent uproar similar to a large waterfall. The spout grew until it was about five feet in diameter, and had a lighter appearance in the centre about three feet in diameter, in which the water streamed up, and on each side of this a darker band about one foot in breadth, in which the water was descending. The motion in both the upward and downward currents was very rapid. The spout lifted and bent forward about half-way between the cloud at the top and the surface of the water. At that time it was about one thousand five hundred feet from the ship. The duration of the spout from the beginning of the formation until it broke loose from the surface was about ten minutes.

"The barometer was 30·10 in. immediately before the whirlwind was seen and stood at 30·16 in. immediately after the passage of the spout. There was no marked change in temperature, but one could notice an odour of sulphur in the air which was dissipated when the wind shifted to north-north-east."

THE METEOROLOGICAL CONDITIONS OF AN ICE-SHEET.—At the December meeting of the Royal Meteorological Society Mr. C. E. P. Brooks read a paper on "The Meteorological Conditions of an Ice Sheet and their bearing on the Desiccation of the Globe." As the regions occupied by extensive ice-sheets at the present day, viz., Antarctica and Greenland, are the centres of permanent high-pressure areas, with slight precipitation, he infers that the regions occupied by similar ice-sheets in the Glacial period were likewise occupied by permanent anticyclones. The maximum extent of glaciation occurred at about the same time in different regions of the globe, and also coincided with the maximum of the pluvial period, or period of greater rainfall than the present, in the unglaciated regions. But a general decrease in temperature should lead to a decrease, not an increase, in the amount of evaporation, and hence of precipitation. Mr. Brooks says that the explanation of the paradox lies in the different distribution of the precipitation. Various causes tended to minimise the effect of the fall of temperature in decreasing evaporation; thus, while the total precipitation over the globe may have been somewhat less than now, so little of it fell over the ice-sheets that the remainder, falling upon the unglaciated areas, rendered these considerably moister than now. Since the culmination of the Ice Age desiccation has progressed with the retreat of the ice. Slight reversals have taken place: an example is the period, cold in the north, moist in the south, from the ninth to the thirteenth century.

DIURNAL VARIATION IN THE AMOUNT OF RAINFALL.—In the "Meteorological Notes" for December, 1913, reference was made to the duration of rainfall, and particulars were given of the monthly *duration* in hours for several stations in various parts of the country during 1912.

Comparatively little information is available as to the diurnal variation of the *amount* of rainfall in the British Isles, as the hourly amounts are rarely tabulated. The Meteorological Office has, however, for many years past published such tabulations in the *Hourly Readings* from the records of its four observatories. The annual average hourly amounts, as recorded at these observatories for the forty years 1871–1910, are given in Table 12. In this table has also been included similar data for Southport, but the averages are only for the ten-year period 1902–1911.

TABLE 12.

DIURNAL VARIATION IN THE AMOUNT OF RAINFALL IN INCHES.

Observatories.	A.M. 1	2	3	4	5	6	7	8	9	10	11	*Noon.*
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Valencia	2·49	2·44	2·60	2·63	2·64	2·54	2·62	2·52	2·48	2·19	1·99	2·19
Aberdeen ...	1·18	1·22	1·22	1·37	1·38	1·38	1·37	1·34	1·32	3·16	1·07	1·16
Falmouth ...	2·04	2·07	2·22	2·15	2·01	2·08	1·98	2·07	1·93	1·90	1·54	1·71
Kew	·95	·99	·98	·98	1·07	·98	·98	·92	·93	·95	·86	1·01
Southport ...	1·37	1·41	1·26	1·52	1·53	1·40	1·35	1·24	1·28	1·17	1·07	1·16

Observatories.	P.M. 1	2	3	4	5	6	7	8	9	10	11	*Midnight.*
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Valencia... ...	2·04	2·08	2·10	2·10	2·23	2·29	2·31	2·34	2·28	2·32	2·39	2·43
Aberdeen ...	1·31	1·27	1·33	1·35	1·41	1·37	1·24	1·21	1·26	1·23	1·21	1·18
Falmouth ...	1·70	1·79	1·73	1·71	1·78	1·81	1·80	1·81	1·82	1·87	1·86	1·98
Kew	1·08	1·05	1·17	1·15	1·18	1·05	1·04	1·01	·99	·92	·90	·91
Southport ...	1·22	1·34	1·40	1·38	1·32	1·39	1·36	1·27	1·18	1·22	1·39	1·40

The average yearly total of the rainfall at each of the observatories for the periods in question is: Valencia, 56·24 in.; Aberdeen, 30·74 in.; Falmouth, 45·36 in.; Kew, 24·05 in.; and Southport, 31·63 in.

At the west-coast stations, viz., Valencia, Falmouth, and Southport, the principal maximum occurs in the early morning hours about 3–5 a.m., while at Aberdeen, which is on the east coast, and at Kew, which is more inland, the maximum takes place in the afternoon at 5 p.m. It is very remarkable that the minimum at all the above places should occur at 11 a.m.

In connection with this it may be interesting to refer to the old weather proverb:

Rain before seven—
Fair before eleven

An explanation may possibly be found in the tendency of small secondary disturbances to form at particular hours, while during the winter months there is a marked tendency of large cyclones to come in from the Atlantic with increased intensity during the night.

WIND GUSTS.—At the meeting of the Aëronautical Society on January 7th Dr. W. N. Shaw, F.R.S., gave a lecture on "Wind Gusts and the Structure of Aërial Disturbances." He stated that gusts are the expression of turbulent motion in the atmosphere. They are most conspicuous near the surface, and may be attributed to the effect of moving air, which change the uniform motion of a steady current into pulsating motion with eddies. The most fully developed form of eddy-motion in the atmosphere is the cliff eddy. In other cases the vortices rapidly disintegrate, and so far the eddy-motion has not lent itself to numerical measurement. Eddy-motion is found in persistent forms, and can arise spontaneously in the free atmosphere, probably in consequence of thermal convection. The elements of eddy-motion to be found in a line squall may give rise to temporary eddies with a vertical axis. Local convection in the atmosphere must inevitably give rise to local differences of pressure, and hence to local winds, which are shown in anemometers as recurring squalls. Consequently the causes and origin of recurring squalls should be looked for in the thermal changes due to local convection.

MICROSCOPY.

By F.R.M.S.

THE STRIDULATING ORGANS OF INSECTS.—The methods by which some insects produce sounds which are audible to human ears are of considerable interest to the microscopist, since, having no lungs like animals, the noises are the results of vibrations caused by mechanical means, and the apparatus employed in the production of such sounds is usually visible under the microscope. Insects probably make other sounds which, though inaudible to us, are well understood by their own species, and we are perhaps in error in classing them amongst "dumb creatures." In the case of the grasshoppers and the crickets the noise is generally caused by raising the tegmina above the back and rapidly rubbing their inner surfaces together, the one on the left carrying a row of hard bead-like teeth and the other a similar row ranged along the edge of a tightly stretched membrane of circular shape, which doubtless acts as a resonator. In many of the cricket tribe this tympanic membrane is found on both tegmina. When these rows of teeth are in contact, the rapid passage of one along the other produces vibrations which, though of high pitch, are within the compass of our organs of hearing. In the *Pneumorides*, however, the arrangement is different, there being a series of chitinous ridges on both sides of the insect's abdomen ranged across a curved tapering tube closed at its large end by a resonant membrane. These ridges are acted upon by a row of small teeth on the inner side of the femur of each hind-leg, arched in shape over a space closed in on both sides by a tense membrane. In this case, the ridges being fewer in number and wider apart, the number of vibrations per second is less than those produced by the crickets and the grasshoppers, a much lower tone being the obvious result. This has been described by one observer as being "like the overtone produced by blowing too hard through a child's penny trumpet," and the whole body being inflated and acting as a resonator the sound is heard on a still night at a distance of nearly half a mile. The females of this genus, being unable to fly, are provided with remark-

able auditory organs, which are no doubt attuned to vibrate in sympathy with the tones produced by the males. In some of the ants a very interesting stridulating organ may be seen on the lower portion of the second segment of the abdomen, consisting of many rows of fine elevations which are acted upon by the incurved edge of the preceding segment, and produce a very distinct squeak when in operation. R. T. L.

THE ROYAL MICROSCOPICAL SOCIETY.—The annual meeting of the Royal Microscopical Society was held at 20, Hanover Square, on Wednesday, January 21st. The report of the council on the year's work and the treasurer's accounts were read, and disclosed a highly satisfactory condition of affairs. After the election of officers for the ensuing year the president, Professor G. Sims Woodhead, gave his presidential address on "The Microscope in Medicine." It is impossible in the brief space at our disposal to give a detailed report, but even well-informed fellows must have been astonished at the all-important part the microscope has played in the development of medical science.

The far-reaching deductions made by observers such as Malpighi and Leeuwenhoek with very inadequate means in bygone centuries, and the work of Pasteur, who, like Leeuwenhoek, was a layman, were reviewed. The fuller understanding of function by the examination of structure and the ability to determine the malignant and benign tumour by microscopic examination were described. Then followed details of the patient investigation which established the cause of malaria to be the Anopheles mosquito, whereby liability to this disease has been immensely reduced, and the experiments which led to the discovery that the flea of the rat was the cause of bubonic plague, in consequence of which it may be said with certainty that, provided there is cleanliness, and the absence of rats is ensured, no scourge of bubonic plague need ever occur again—these and many other diseases which have from time immemorial menaced the life of the resident in the uttermost parts of the earth have been understood, and cause and effect revealed, by means of the microscope. These notes merely touch the fringe of the subject mentioned in this masterly address, which deserves to be read in its entirety in the Society's Journal by all who are interested in knowing what has been done for the benefit of humanity at large by the use of the microscope.

QUEKETT MICROSCOPICAL CLUB.—At a meeting held on December 23rd, 1913, Mr. B. M. Draper read a paper on "A Live Box for the Observation of Insects and Similar Objects." This was intended for the display, under the lowest powers, of large creatures such as house-flies. It is, in effect, a transparent chamber of the shape and size of a small pill-box. The body is made of a short piece of glass tube, say, one-third of an inch deep by two-thirds of an inch diameter. This is cemented to a three-inch by a one-inch slip. The lid is a circular piece of glass with three short pins fixed at equal distances round the edge. These project downwards so as to clasp the body when the lid is in position. For the illumination of objects in this box, or any large opaque object, an ordinary concave microscope mirror fitted to the end of a jointed arm and giving universal movement, attached to the upper side of the stage and used with lamp and bull's-eye, is very satisfactory.

Mr. B. M. Draper also discussed dark-ground illumination with the Greenhough binocular microscope. Trial of various patterns of patch stops proved the best form to be two small circular patches placed side by side in the same plane and close together. The two patches must be arranged opposite the two front lenses of the twin-objectives.

Mr. E. M. Nelson, F.R.M.S., contributed a paper "On '*Amphipleura Lindheimeri*.'" The recent discovery was mentioned of a coarser form of this well-known test, having but 67,000 striae per inch as against 77,000 in the old form. It is therefore necessary to distinguish between these two forms when quoting *Lindheimeri* as a test. The new form can be recognised by its very long terminal nodules, a terminal nodule being one-third of the whole length of the valve. In the old form it is only one-fifth. The length-breadth ratio in the new form is 7:5; in the old, 8·5.

PHOTOGRAPHY.

By EDGAR SENIOR.

TO CONVERT A PHOTOGRAPH INTO A LINE DRAWING.—In many instances where a photograph is employed for illustration purposes it is only a portion that is really required, and an advantage would be gained by having this in outline, so that a block could be prepared that would print well on the same paper as the printed matter. In order to produce a result which would be suitable for the purpose a bromide print from the negative is first made, greyer in tone than usual, and on a smooth paper that will allow of being readily worked upon. The print is fixed, washed, and dried, when it is ready for working upon, this being done with a waterproof ink applied with a steel pen in such a manner that the chief features in the photograph which are required are translated into lines, which are more or less thick. When the drawing is completed the print which has been worked upon is placed in a dish, and a solution of mercuric chloride of the following strength poured over it:—

Mercuric chloride	1 ounce
Water	16 ounces
Strong hydrochloric acid ...	½ drachm

The print rapidly bleaches in this solution, leaving the ink lines intact upon a white ground, and after washing and drying it is ready for copying, for which purpose a slow gelatine plate and a hydroquinone developer may be used, the particular formula for the developer which has been found to give very good results being as follows:—

Hydroquinone	4 grains
Sodium sulphite	24 ,,
Potassium bromide	1 grain
Sodium carbonate	36 grains
Potassium carbonate	36 ,,
Water to	1 ounce

This developer will be found to yield great density, combined with clear glass lines in nearly all cases, unless the plate be greatly over-exposed. Another method that may be employed in place of the bromide paper for making the initial print upon consists in sensitising paper with a solution of ammonio-citrate of iron, and, after printing from the negative upon it, developing with a weak solution of potassium ferricyanide (red prussiate of potash). This gives a blue image, which does not require to be removed after it has been worked upon with the waterproof ink prior to copying, especially if a collodion plate be used, which can afterwards be treated in the necessary manner to obtain the required contrast. Should the blue colour, however, be too strong it can be reduced by prolonged washing; or, if it be desired to remove it altogether, this may be accomplished by the use of an alcoholic solution of potassium oxalate, or by the use of water made alkaline with a little caustic potash. For rapid work with the bleach-out process it is preferable to use a saturated alcoholic solution of mercuric chloride, and when the bleaching is complete to rinse the print with some clean spirit and then dry. Not only is time gained by adopting this method, but fine lines are less liable to become blurred. Of other methods for bleaching that with copper bromide is to be recommended. For this purpose a solution is made as follows:—

Copper sulphate	50 grains
Potassium bromide	30 ,,
Water	2 ounces

The print, after being bleached in the above, is well rinsed and then dried. It is always advisable that prints intended for drawing upon should be attached while still damp to

a sheet of glass by means of a little gum at the edges, as they will then dry perfectly flat and be in a much better condition for working upon.

PHYSICS.

By A. C. G. Egerton, B.Sc.

X-RAYS.—When X-rays fall on a substance they give rise, not only to "scattered" radiation of much the same type as the original rays, but also to "secondary" rays of definite kind depending on the nature of the substance. The nature of the rays varies according to their penetrating power, which is measured by their absorption in aluminium. A "hard" ray penetrates a greater thickness of aluminium than a "soft" ray. The penetrating power, or "hardness," of a scattered radiation depends on the hardness of the incident radiation; but it is not usually quite so penetrating as the incident radiation. The softer rays are scattered more than the hard rays. About a tenth of the energy, abstracted from rays of average hardness passing through a thin material, is converted into scattered radiation. The secondary radiation, on the other hand, is homogeneous in character; it is not composed of rays of varying hardness, but for the same metal the penetrating power is perfectly definite. The hardness of these secondary rays depends on the atomic weight of the metal on which the primary beam of X-rays falls. The secondary radiation is not marked until metals of atomic weight above 40 are employed; the energy of the emergent radiation from substances with smaller atomic weight than 40 is chiefly composed of scattered radiation. The ratio of the strength or intensity of the secondary radiation to the incident radiation increases as the hardness of the latter approaches that of the secondary radiation characteristic of the metal; but if the hardness of the primary beam is less than that characteristic of the metal the secondary rays will not be excited at all. Thus rays characteristic of zinc excite those of copper; but copper rays would not excite zinc rays. For the heavier elements there is another set of secondary rays emitted; rays much softer relatively to the other secondary rays which the element emits. For the lighter elements it is possible that this second set of secondary rays is formed, but being so soft they escape detection, and are absorbed before they reach the measuring instrument. On the other hand, the secondary radiation of the first type emitted by very heavy elements, such as bismuth, have not been obtained, because it is necessary to use a primary beam harder than the secondary rays of bismuth, and this is not possible owing to the limited potential difference which can be applied to an X-ray tube. Consequently only the secondary radiation of the second type has been observed. It is found that the radiation of the first type (the "K" series) from an element of atomic weight W' is connected with that of the second softer type (the "L" series) from an element of atomic weight W by the relation $W' = \frac{1}{2}(W - 50)$.

When light falls on certain substances they fluoresce; that is to say, they give out light of a particular colour characteristic of the substance, *e.g.*, quinine, petroleum, eosine, rhodamine. These secondary X-rays have therefore been termed fluorescent radiations.

Besides these radiations X-rays excite other kinds of rays when they fall on a substance. These are secondary β-rays; rays of the same nature as cathode rays obtained in vacuum tubes, or the β-rays from radium; they are negatively charged.

The nature of the secondary β-rays so formed is analogous to the different types of X-radiation to which a beam of X-rays gives rise; but the velocity is used as the determining factor, instead of the hardness, as with the X-radiation. The rays have different velocities, but the greater number have a velocity near the maximum velocity which is determined by the quality of the exciting X-rays, and there is a definite secondary β-radiation for any particular element. It is thus the fastest β-rays emitted from any substance on which copper X-rays fall which would be termed the "copper secondary β-rays."

The X-rays do not by any means cause every atom through which they pass to emit a β-ray; not more than one millionth of them are so affected. The X-rays, as is well known, are excited by the stopping of cathode rays by material substances. It is found that the fastest cathode rays which cause the emission of a certain beam of X-rays have the same velocity as the fastest secondary β-rays, which can be produced by those X-rays; and also the following fact is of importance, viz., that the intensity of the X-rays produced from an anticathode of a particular metal by kathode rays increases very rapidly as the velocity of those kathode rays becomes sufficiently large to give the characteristic radiation of that metal.

Thus kathode rays give rise to X-rays, X-rays to scattered X-rays, secondary X-rays and secondary β-rays, and secondary β-rays excite other X-rays, and so on. The energy of the radiation is divided up among these various types of ray. The absorption of X-rays increases with the atomic weight of the substance through which they pass, and with the softness of the rays. But if the rays are just of the hardness to excite secondary X- and β-rays in the substance the absorption increases very considerably, because so much of the energy of the primary beam is utilised in order to excite the radiation characteristic of the substance. This is somewhat similar to the absorption bands obtained with fluorescent substances.

In a way, then, the elements possess properties, as regards X-rays, analogous to their characteristic spectra for light; but the properties are simpler: they give out only two definite types of rays, instead of a number of different wave-lengths of light. The X-rays affect the very internals of the atom; light only affects the external portions of an atom.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A., LL.D.

EFFECT OF INTOXICATING MALE PARENT.—Dr. Charles R. Stockard has for three years made experiments in intoxicating male guinea-pigs by inhalation of alcohol (which does not spoil their stomach), and has reached the very important conclusion (see *American Naturalist*, November, 1913) that an alcoholised male guinea-pig almost invariably begets defective offspring, even when mated with a vigorous normal female. The effects were manifest in the second-generation animals as well. "The poison injures the cells and tissues of the body, the germ-cells as well as other cells, and the offspring derived from the weakened or affected germ-cells have all the cells of their bodies defective."

DEEP-WATER FISHES ON THE PARIS MARKET.—J. Pellegrin calls attention to the not infrequent occurrence on the Paris market of rare fishes from deep water—two hundred metres or so. It seems that the fishermen are going further afield and working at greater depths. Among the forms noted are the following: *Beryx decadactylus*, *Beryx splendens*, *Hoplostethus mediterraneus*, *Dentex macrophthalmus*, the archaic Bramid *Pterycombus brama*, and *Macrurus atlanticus*. Portions of the very rare *Parazenopsis conchifer* were also obtained. The "consommation parisienne" seems to be becoming more exquisite than ever.

THE GOLDEN-EIGHT MOTH.—Charles Nicholson calls attention to the remarkable history of this moth (*Plusia moneta*) in Britain. Its first appearance seems to have been in 1857; a great invasion occurred in 1890; since then it has spread over England. During the last half-century or so it has diffused persistently westward and southward from its Russian headquarters. The name "golden-eight" refers to the markings on the golden-grey wings. When the moth is at rest it puts on a mantle of

invisibility. "It strongly resembles a dead and dry leaf still attached to the stem. The front legs are stretched out straight in front of the head at a right angle to the axis of the body, the second pair of legs being pressed close to the body, while the last pair just hold to the support, almost, or quite, covered by the tips of the forewings which just touch beyond the body, the moth appearing to be clinging to its support by the front legs and wings only. It falls to the ground when touched."

MYRMECOPHILOUS BEETLES.—Karl Jordan has made an interesting study of the glands of Lomechusa and Atemeles and other related beetles which live as guests in ants' nests. Numerous unicellular glands on the sides of the abdomen produce the secretion that the ants lick with evident gusto. But there are also numerous offensive glands, common to other beetles of the same sub-family Aleocharinae, which are not myrmecophilous. The secretion of these offensive glands has an odour like that of amyl-acetate, or methyl-heptenon; and it has, like these substances, a stupefying effect on the ants. It is used against stranger ants, or against the hosts themselves when they are troublesome. The possession of the offensive glands gives the beetles a certain standing, so to speak, but it is on the possession of the palatable secretion that the myrmecophilous partnership depends.

AUTOTOMY IN *LINCKIA*.—Hubert Lyman Clark has studied the extraordinary regenerative capacity of *Linckia guildingii*, a starfish common on the reefs of Jamaica. Rays, severed at some distance from the disc, give rise to new discs and rays, just as well as those which separate close to the disc. Arms are thrown off at irregular intervals for a long period, if not throughout life. In the autotomously severed rays growth continues, especially at the proximal end, where new rays soon begin to appear, radiating out from a new mouth. Growth of the new rays is much more rapid than that of the parent ray, and they may ultimately approximate to it in size. The conclusion come to is that the autotomy is an asexual method of reproduction of prime importance.

REPRODUCTIVITY.—Dr. Th. Mortensen calls attention to the extraordinary fecundity of the starfish, *Luidia ciliaris*, which is well known in our seas. The beautiful red ovaries are arranged in a double series in each arm—three hundred in an arm thirty centimetres long. As the species is seven-rayed a complete female of that size, which is nearly the average, has two thousand one hundred ovaries. In one ovary there are at least three hundred thousand eggs, probably nearer half a million. As the ovaries are smaller towards the tip of the arm it may be just to take the mean number of eggs per ovary at one hundred thousand, and the number of ovaries may be reduced to two thousand. This gives the number of eggs in a grown female at no fewer than two hundred millions. Yet the larvae are relatively rare at Plymouth, and the adults are far from common. "What a waste of eggs must here take place!"

CRYPTODROMIA AND ITS SPONGE.—Zoölogists are well aware that the little crabs of the genus Cryptodromia are in the habit of masking themselves with a piece of sponge or ascidian, or the like. R. P. Cowles has recently watched the whole process of sponge-cutting. The naked crab (*Cryptodromia tuberculata*, in the Philippines) cuts a groove on an encrusting greyish sponge, works its way under it, and dislodges it. In a short time the ragged edges of the sponge should grow smooth and neat. The cutting is done with the forceps, but the dislodged piece is caught hold of and carried by the last pair of legs. "It is a surprise to the collector when, on turning over a rock covered with large and small patches, he sees some of the smaller patches suddenly become animated and crawl away. Another surprise is in store for him when he picks up one of these small patches and finds it to be the cover of a crab carefully hollowed out so as to fit the outline of the carapace and tightly held in place by the last pair of legs, whose dactyli (terminal joints) are hooked into the inturned rim."

REVIEWS.

BOTANY.

Researches on Irritability of Plants.—By J. C. Bose. 376 pages. 190 illustrations. 9-in. × 6-in.

(Longmans, Green & Co. Price 7/6 net.)

The author has, in his more recent researches on irritability in plants, used new methods by which the scope of investigation has been enlarged and a higher degree of accuracy secured. In the present work the various excitatory phenomena of plants have been investigated by means of mechanical response under the action of a testing stimulus. The author gives, if anything, too much detail regarding his own experiments; though there is a summary at the end of each chapter, it is rather difficult for the reader to get hold of any general principles concerning plant irritability. In a work of this scope one naturally expects to find references to the work of others than the writer himself, but, since practically no such references are given, we are presumably to infer that somehow or other the rather extensive, though specialised, field covered by the author was entirely overlooked by plant physiologists until he began his researches. The main thesis of the book is that hardly a single phenomenon of irritability is observable in the animal which is not also found in the plant, and that the various manifestations of irritability in the plant are identical with those in the animal.

F. C.

Makers of British Botany: A Collection of Biographies by Living Botanists.—Edited by F. W. Oliver. 332 pages. 28 illustrations. $8\frac{1}{4}$-in. × $5\frac{1}{2}$-in.

(The Cambridge University Press. Price 9/- net.)

This volume represents in somewhat expanded form a course of lectures given at University College, London, in 1911, by various botanists, the lecturer in each case being either a worker in the same field as, or in some other way having a special qualification to deal with, his allotted subject. The period covered by the lives of the British botanists here dealt with is nearly three hundred years, and the subjects of the biographies given are Morison, Ray, Grew, Hales, Hill, Brown, Sir William Hooker, Henslow, Lindley, Griffith, Harvey, Berkeley, Gilbert, Williamson, Marshall Ward, the Edinburgh Professors from 1670 to 1887, and Sir Joseph Hooker. All the biographic sketches included in this volume are exceedingly readable and interesting, showing fine insight into and sympathy with the labours of those who have been so largely responsible for the building up of botanical science in general and of the British school of botany in particular. In several cases it is obvious that the writer has done a considerable amount of literary research in fulfilling his allotted task, and in this book we find many interesting details not given in any other history of botany. Everyone interested in the progress of botany in this country should read these interesting essays.

F. C.

ECONOMICS.

The Standard of Value.—By WILLIAM LEIGHTON JORDON. 292 pages. 8½-in. × 5½-in.

(Simpkin, Marshall, Hamilton, Kent & Co. Price 7/6 net.)

The fact that this book is now in its eighth edition may be taken as some indication of the demand there is for it. The work is a very interesting statement of the case for bimetallism, and, as the author points out in his preface, although the large supplies of gold recently obtained from South Africa "seemed likely to take from the double-standard question the position of practical importance" which it held during the thirty years previous to the publication of the seventh edition of his book (in 1896), "the currency legislation of the Indian Government has made it again a burning question."

Mr. Jordon bases his main argument for bimetallism on the ground that if a debt is contracted in silver it is obviously unfair to the debtor to compel him to pay in gold. Now the National Debt was mainly contracted in silver; and in the same manner as it would be unjust to the creditor to allow the debt to be discharged in copper, so is it unjust to the debtor to force him to pay in gold. Moreover, as the value of the silver pound has decreased, and that of the gold pound increased, compared one with the other, consequent upon the establishment of the monometallic standard, it follows that the National Debt has been artificially augmented in amount in a corresponding ratio.

Mr. Jordon is in favour of free coinage of both silver and gold; free, that is, in the sense of unlimited, not in the sense of gratuitous; and he is of the opinion that, if such policy cannot be agreed upon by the nations of financial importance by treaty, England would do well to take the lead. Whatever may be said for or against these views, they are certainly worthy of careful consideration by economists. Mr. Jordon's book, however, loses a good deal of force, I think, through the fact that it consists of a number of papers and letters, written at various times and on various occasions, which appear to have been revised mainly by the addition of footnotes. There is consequently not a little overlapping, and the various chapters do not, as one would wish, present the argument in a consecutive form. I would suggest that Mr. Jordon, if he contemplate a further edition, should rewrite the book from beginning to end in a methodical manner.

H. S. REDGROVE.

FORESTRY.

The Theory and Practice of Working Plans (Forest Organisation).—By A. B. RECKNAGEL. 235 pages. 8 illustrations. 9-in. × 6-in.

(Chapman & Hall. Price 8/6 net.)

This book will be of the utmost value to all who are interested in the methods of forest management, since it contains in an extremely clear and condensed form the results of the author's experience, both in Europe and America, in forestry work. After describing the various methods that have been proposed for successful forestry, the author gives an interesting account of the forest areas of France, Germany, and Austria, with notes on the methods of management adopted in these countries. At the end of the book there are set out numerous schedules which the author suggests should be used for the recording of forestry data.

F. C.

The Important Timber Trees of the United States.—By S. B. ELLIOTT. 382 pages. 46 illustrations. 8½-in. × 5½-in.

(Constable & Co. Price 10/6 net.)

This book is divided into two parts, the first dealing with the growth and growing of trees in general, the second with the various types of forest tree grown in America (including, of course, most of those grown in Europe too). In the first section the author treats the general principles of forestry in a very interesting manner, keeping the physiology and ecology of trees well in view; while in the second section we find many interesting notes on the chief forest trees of the United States, including both the indigenous species and those that have been introduced from Europe. The book is beautifully illustrated, and is produced at a very moderate price.

F. C.

GILBERT WHITE.

Bulletin of the British Ornithologists' Club.—By W. H. MULLENS. No. CXC. 27 pages. 8½-in. × 5½-in.

(Witherby & Co. Price 2/6 net.)

Every book, article, or reference which brings before Englishmen the importance, value, and far-reaching effects of Gilbert White's work should receive a hearty greeting; and therefore Mr. Mullens's labour of love must receive from us a warm welcome, as it will be sure to show many ornithologists what they owe to the curate of Selborne. They will learn from the second part something of the life of the naturalist from the pen of one who, perhaps more than anyone else living, has studied White's work, collected his letters, read his journals, and lectured upon his home in Selborne and his visits to Sussex. The first part, which is a guide to Selborne, was written, as was the other paper, in connection with a proposed expedition of the British Ornithologists' Club to Selborne (to celebrate its coming of age), but which fell through owing to the death of Dr. Sclater. It will not, however, have been prepared in vain, for it will lead to many private visits, we should imagine, to the now world-famous village.

W. M. W.

NATURAL HISTORY.

Birds of a County Palatine.—By ALFRED TAYLOR. 148 pages. 148 illustrations. 12-in. × 9½-in.

(The "Wild Life" Publishing Co. Price 16/- net.)

It seems as if the interest aroused by birds can never be exhausted, and the naturalist who is at the same time an expert photographer, besides enjoying all the delights of the chase without any qualms of conscience, can impart to others no small share of his pleasure from his pictures. Mr. Alfred Taylor, upon whose work we have the pleasure of commenting, in the book under consideration gives us photographs and descriptions of some of the more important of the seventy-five species of wild birds which he has found nesting within a radius of ten miles of Whalley where he lives. He has made a special endeavour to illustrate the habits and life-histories of his subjects which has been crowned with success. It would be very difficult to obtain a better photograph than that of the barn owl which is used as a frontispiece, or of the tawny owlet which faces page 56. The series showing the story of the young cuckoo is also most attractive, and from this we are enabled by the courtesy of the publishers to reproduce the illustration which we give in Figure 55. The curlew and the woodcock might also be picked out for mention, and of the missel thrush Mr. Taylor has succeeded in getting some very pleasing pictures. The accounts of the birds and the details with regard to the way in which the photographs were obtained, as well as those of the apparatus used, should prove of interest and help to others who would fain follow in the footsteps of Mr. Taylor. He begins his preface with an extract from Gilbert White, and to the many disciples our great field naturalist we commend "The Birds of a County Palatine."

W. M. W.

Desert and Water Gardens of the Red Sea.—By CYRIL CROSSLAND, M.A. 158 pages. 91 figures. 12 diagrams. 9¾-in. × 6-in.

(The Cambridge University Press. Price 10/6 net.)

Biologists have, as is right, their own way of looking at things, and Mr. Cyril Crossland's account of the people of

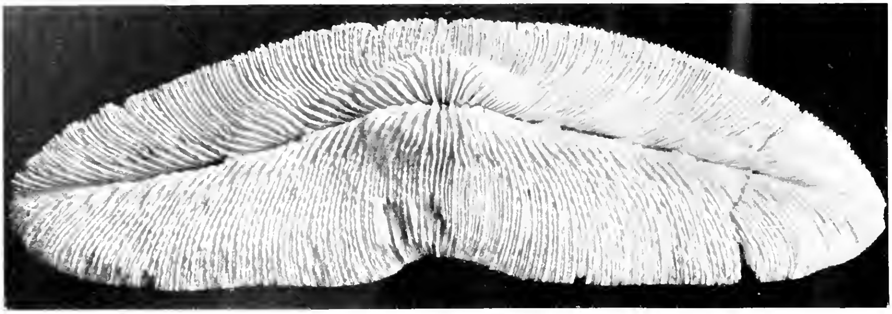


FIGURE 56. *Herpolitha*, an elongated fungid coral.

FIGURE 57. Old Coral bored by a mollusc (*Lithodomus*).

FIGURE 58. Section of a large Shell bored by molluscs and sponges.

FIGURE 59. The young form of the Mushroom Coral (*Fungia*).

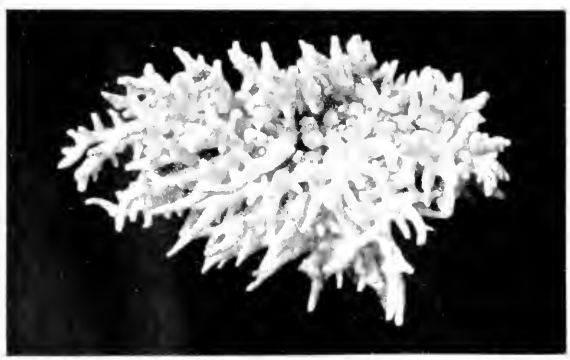


FIGURE 60. A stony Seaweed (*Lithothamnia*).

(From "Desert and Water Gardens of the Red Sea" by Cyril Crossland. By the courtesy of The Cambridge University Press.)

the Red Sea Coast is as fascinating as his description of the reefs and corals and sponges of the shore. We learn much of the daily life of the people, of their curious superstitions and their general behaviour. No one will kill a cat or drown young kittens, though they would bury superfluous puppies without any qualm. This Mr. Crossland thinks is a relic of the ancient Egyptians' reverence for the former animals. It is further suggested that the word "biss" which is the name for cat is the same as our word "puss" and arose independently in the two countries. Not the least interesting part in the book is that dealing with the sailors of the Red Sea, including those who are engaged in the occupation of pearling. Mr. Crossland's book is most attractive and should be read by everyone interested in his fellow-men. By kind permission we reproduce several of the illustrations (see Figures 56-60.)

W. M. W.

PERSPECTIVE.

Perspective made Easy by Means of Stereoscopic Diagrams.—By C. E. BENHAM.

(Colchester: Charles E. Benham. Price 6/-.)

These diagrams will prove of considerable help to those who have a difficulty in realising the different planes made use of in working out a perspective problem. The relative positions of the P.P., G.P., C.V., Eye, V.P.'s., M.P.'s, and other points are shown with the solidity associated with stereoscopic relief.

The accompanying pamphlet explains the theoretical part of the subject very clearly.

Teachers of Perspective should welcome these diagrams as a real help in imparting a knowledge of the subject.

It would be an advantage in a future edition to print the descriptions of the figures on the left side and under the left diagram. They could then be read when viewing the diagrams in the stereoscope.

E. J. B.

PETROLOGY.

Igneous Rocks. Vol. II.—By J. P. IDDINGS. 685 pages. 18 figures. 8 maps. 9-in. × $6\frac{1}{2}$-in.

(Chapman & Hall. Price 25/6 net.)

The completion of Professor Iddings's great work on Igneous Rocks marks an epoch in petrological science. The first volume treated of the composition, occurrence, texture, and classification of igneous rocks—in a word, of their petrology. The present volume deals in natural sequence with their petrography—systematic description and geographical distribution. The book is on a scale that has never yet been attempted in petrological works. It marks the definite establishment of the quantitative spirit in petrology, and, as in other sciences, the substitution of qualitative by quantitative methods is bound to have an enormously stimulating effect on the science.

The book makes it clear that petrographers cannot afford to wait for a "natural" or genetic classification of igneous rocks. The factors on which a natural classification can be based have not yet been discovered. The author of this work and the other three petrographers (Cross, Pirsson, and Washington) with whom he was associated in the construction of the American Quantitative Classification assert that there are no natural factors as yet known which are suitable as a basis for classification. Hence they established the Quantitative Classification, based on chemical composition and treating igneous rocks as a series continuous in all directions, which is only capable of arbitrary subdivision into compartments of equal value, just as, for example, is the scale of temperature. It is hard for petrographers to controvert the philosophical basis of this classification; it is easier for them to criticise its architecture. On this ground it is to be feared that the verdict will be an adverse one. The majority of petrographers will probably come to the conclusion that the American Quantitative Classification is not suited to their working needs, since it is based on a factor (chemical composition) which cannot be immediately elicited from the rocks, and which cannot be utilised in everyday work because of the sheer impossibility of obtaining chemical analyses of all the rocks the petrographer wishes to classify. From a perusal of this work he will probably come to the conclusion that a quantitative classification based on actual mineral composition—that is, on modal lines rather than normative—is the one necessary to the future progress of petrology, especially when it is seen in this book that Professor Iddings has been obliged to invent a modal classification through which to utilise the Quantitative Classification.

The book is divided into two parts, the first dealing systematically with igneous rocks and their classification, the second with their geographical distribution to form petrographical provinces and regions. In the first part igneous rocks are divided into six groups on what, in the main, is a well-conceived and logical basis of mineral composition. These groups are as follows:—

I. Rocks characterised by Quartz.
II. ,, ,, ,, Quartz and Felspars.
III. ,, ,, ,, Felspars.
IV. ,, ,, ,, Felspars and Felspathoids.
V. ,, ,, ,, Felspathoids.
VI. ,, ,, ,, Mafic Minerals.

A welcome quantitative note is sounded throughout the whole system. Thus in Group I the quartz rocks are defined as those in which the ratio of quartz to felspars is greater than five to three. In Group II the ratio of quartz to felspar must be less than five to three, and greater than one to seven. Similar arithmetical boundaries are established in the other groups, and in most of the minor subdivisions. Thus Group III—felspar rocks—is subdivided as follows:—

A.	Syenites	— $\frac{\text{alkali felspars}}{\text{lime-soda felspars}}$	$> \frac{5}{3}$
B.	Monzonites	,,	$< \frac{5}{3} > \frac{3}{5}$
C.	Diorites and Gabbros	,,	$< \frac{3}{5}$

With regard to texture each group is subdivided into (1) Phaneric and (2) Aphanitic; and the latter are described along with their phaneric equivalents. It is impossible to overpraise the thoroughness and care with which the descriptions are done. The book is a huge compendium of petrographical information, from which petrographers will draw for many years to come.

While, however, the classification is ostensibly modal, in practice the rocks are often assigned to their respective groups on the basis of the norm or mineral composition calculated from the chemical analysis by the methods of the American Quantitative Classification. Many anomalies result from this. For instance, a rock which contains little or no lime-soda felspar may be referred to monzonite on the ground that the anorthite molecule occurs in the norm. The constituents of the anorthite may be taken up in some of the mafic minerals, or occulted in solid solution within the alkali felspars, and thus fail to appear as lime-soda felspar (page 171). It may also be remarked that the ratio of alkali felspar to lime-soda felspar, used as a minor factor in classification (see above), might usefully be replaced by the ratio of alkali-felspar molecules to anorthite molecules, since the proportions of anorthite to albite are now usually obtained with great exactitude from the optical examination of the rocks. The use of lime-soda felspar is really the perpetuation of the "plagioclase," beloved of the qualitative petrographer, as a factor in classification.

Professor Iddings has evidently found it impracticable to use the ratio of "felsic" to "mafic" minerals, corresponding to Brögger's distinction of "leucocratic" and "melanocratic," as the first factor in his modal classification. Here it plays a subordinate classificatory rôle, whereas in the Quantitative Classification, based on the norm, the equivalent ratio of salic to femic minerals forms the basis of the principal divisions. This points to an exaggeration of the importance of this factor in the Quantitative Classification.

In the second part of the book the rocks are treated

as components of petrographical provinces and regions; and, although this is in general well done, the field covered is so enormous that it gives the individual items an effect of scrappiness. The author has evidently ransacked the whole of petrographical literature, as is evidenced by the bibliography of nearly one thousand items given at the end of the book. Another extremely valuable feature is the collection of over two thousand chemical analyses of igneous rocks with their respective norms—a collection which has no equal in petrographic literature. As regards the accuracy of the analyses and norms only one of those tested by the reviewer was incorrect, that of a teschenite on page 528. The latter part of the book is marred by numerous misspellings of foreign names and by misprints.

In spite of some obvious defects, especially the failure (in the reviewer's opinion) to correlate the American Quantitative Classification satisfactorily with a quantitative modal classification, this book is the finest account of systematic petrography yet published, and should hold the field for a long period.

G. W. T.

PHYSICS.

Recent Physical Research.—By David Owen, B.A., B.Sc. 156 pages. 53 illustrations. $8\frac{3}{4}$-in. × 6-in.

(*The Electrician* Printing and Publishing Co. Price 3/-.)

This book is based on a series of articles which have been appearing in *The Electrician* during the last three years, and it represents a well-considered attempt to give a connected account of recent progress in certain branches of Physics. The rapidity with which new developments have appeared during the twentieth century is enough to appal the busy man for whom Science is a recreation or whose own line of work lies in a different direction. To follow intelligently the researches of J. J. Thomson alone may be possible for those who are able to attend his occasional lectures at the Royal Institution; but even these favoured persons will not be sorry to possess a concise account of his recent work on Positive Rays such as may be found in the first two chapters of this book. Other chapters consider Rutherford's work on the α-Particle, Curie's work on Magnetism, the Brownian Movements noticed by the botanist Brown in 1827 and more recently studied by Gouy, Einstein, and Perrin, the Pressure of Radiation, the Aurora, Free Electrons in Metals, and the very strange magnetic alloys composed of non-magnetic metals.

W. D. E.

TELEGRAPHY.

The Wonders of Wireless Telegraphy.—By J. A. Fleming, F.R.S., Professor of Electrical Engineering in the University of London. 279 pages. 54 figures. 8-in. × 5-in.

(Society for Promoting Christian Knowledge. Price 3/6 net.)

The author of this book has already written for the same series "Waves and Ripples in Water, Air, and Aether" published in 1902, in the last chapter of which he gave a short account of radio-telegraphy, then in its infancy. The growing importance of the subject has led him to write a new book in preference to amplifying one chapter of an old one. Much has already been written on the subject, but there is room for a book which, although intended for the general public, does not shirk difficulties. Professor Fleming has faced the problem of explaining in simple non-mathematical language the facts prophesied by Clerk Maxwell, the follower of Faraday, and the forerunner of Hertz. He discusses at some length the history of the wave theory of light, and the nature of the aether. Then follows a chapter giving in historical sequence the development of our present views of electricity and the nature of electrons. After this the book becomes more technical in the sense of being confined to the explanation and history of the methods of producing and of detecting electro-magnetic waves. As is only natural, the Marconi system figures more largely than any other: but other systems are adequately described, and a few pages are given to wireless telephony. The book can be confidently recommended.

W. D. E.

THEOLOGY.

The Present Relations of Science and Religion.—By the Rev. Professor T. G. Bonney, Sc.D., F.R.S. 212 pages. $8\frac{1}{2}$-in. × $5\frac{1}{2}$-in.

(Robert Scott. Price 5/- net.)

This volume forms one of a series entitled "The Library of Historic Theology," edited by the Rev. Wm. C. Piercy, M.A. So much nonsense has been written in the immediate past concerning the relations between Science and Religion that there is every need for a sane book of this character, written by a man who is at once a scientific man of recognised standing and a believer in those eternal verities which transcend science. Science, if I may so put it, has only just recovered from the influence of materialistic metaphysics; but there is no other than a historical and accidental connection between them. In his first chapter Professor Bonney deals with modern physical science, and shows how its conclusions, so far from being antagonistic to religion, point to the existence of one mighty Power and Purpose sustaining all things. He then passes to the realms of biology and geology. He insists on the truth of Evolution, indicating at the same time that the influence of natural selection, though certainly of importance, has probably been overestimated. He is inclined also to believe in abiogenesis, as constantly taking place in Nature through the synthetic production of protoplasm, and in the possibility of its being effected in the chemist's laboratory: a belief which I certainly share. But he points out that there is nothing whatever in these views destructive of a spiritual concept of life or of the teachings of religion. He then proceeds to point out, in further chapters, that there is nothing in the teachings of science which denies the possibility of revelation or miracle. The laws of nature are not data of experience, but inductions therefrom. If an event is recorded contrary to what we regard as natural law, we have no right to deny the event because of our belief in the law—our induction may have been too narrow. The question is, rather: What evidence is there that the event did occur? I do not agree with Professor Bonney, however, when he argues that alleged miraculous happenings should be dismissed from consideration if they are not of high moral significance and indicative of some lofty purpose, on which grounds he bases a criticism of modern spiritualism, whose phenomena are mostly trivial in nature. This seems to me to be a departure from a consistent scientific empiricism; though, of course, the credibility of spiritists, to keep to his case in point, does often extend to ridiculous limits.

The conclusions of Professor Bonney's first two chapters may seem to some readers to be rather vague and negative. I do not see what else could be expected. Science and religion are distinct departments of human thought and activity. The one seeks only to coördinate phenomena, the other to transcend the phenomenal. As such they are complementary, not antagonistic. Science cannot prove the existence of God (though the conclusions of science can be and ought to be used by the philosopher for this purpose), nor can theology enlighten one concerning, say, the laws of astronomy. On the other hand, there is nothing in science which contradicts a genuine religious faith. This, as Professor Bonney points out, has not always been recognised in the past; scientific men have dogmatised about religion, and theologians have dogmatised about science, with disastrous results. However, a much improved condition now obtains. The essential truth of a religion is not destroyed by the errors of some of its exponents; and as a man of science Professor Bonney not only declares in favour of religion as against atheism or agnosticism, but definitely defends Christianity as the noblest, and, on historical and other grounds, most credible form of religion. I hope that his excellent book will be as widely read as it deserves.

H. S. Redgrove.

SOLAR DISTURBANCES DURING DECEMBER, 1913

By FRANK C. DENNETT.

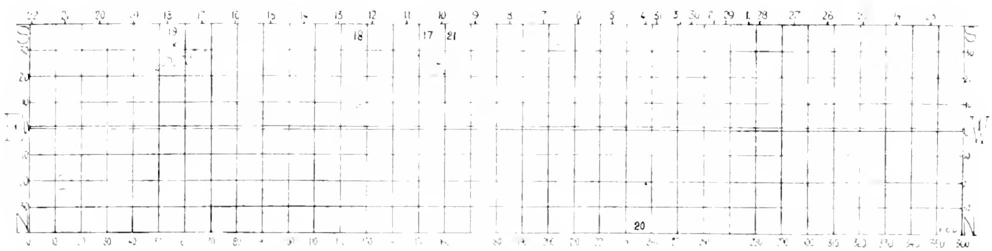
DECEMBER proved a very unsatisfactory month to the solar observer, eight days (2nd, 3rd, 6th, 7th, 10th, 11th, 15th, and 22nd) being missed entirely. On five days (1st, 16th to 18th, and 24th) faculae only were visible; on seven (9th, 12th to 14th, 21st, 30th, and 31st) dark spots were seen; but on the remaining eleven the disc was reported free from disturbance. The longitude of the central meridian at noon on December 1st was 277° 3'.

No. 17.—First seen on the 9th, a larger spot with two smaller ones following it apparently forming part of an imperfect ellipse. On the 12th there was a line of pores running obliquely from 25° to 27° S. latitude. Next day a curve of pores was at the western extremity, and one pore at the eastern. On the 14th a solitary pore was in the place seemed to be gone, but a new trail had broken out, with a more northern trend. On the 3rd the observation was somewhat unsatisfactory, and only the leader was seen. When the area was next visible, on the 6th, it was marked by faculae only. The leader attained a diameter of nine thousand miles.

No. 21.—A group of four spotlets first seen on the 31st surrounded by faculae. The components dwindled, and were last seen on January 2nd.

A facular disturbance was seen December 1st near the north-western limb. Also on the 13th, at longitude 203°, S. latitude 32°. On the 13th and 14th a fine group of faculae was visible in longitude 48° to 68°, S. latitude 22° to 30°. A pale area of faculae around 13°, 20° N., visible on the 16th, probably a return of that seen on the 1st.

DAY OF DECEMBER, 1913.



of the leader, the outline of the area being brilliant with faculae, the latter remaining visible until the 16th. The leader had a maximum diameter of seven thousand miles, the group extending fifty-seven thousand miles.

No. 18.—A solitary pore upon the 12th, but on the 13th two small irregular spotlets, the area being marked by a dull marking on the 14th, and by a facula from the 16th until the 18th.

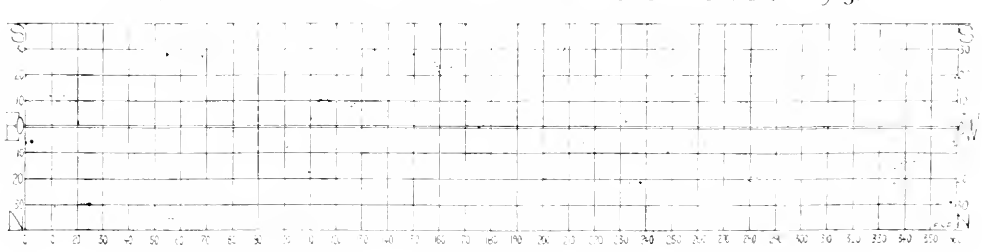
No. 19.—A tiny pore embedded in strong faculae. The position shown is approximate only. It was only seen on the 21st, the facula being near the limb on the 24th.

No. 20.—A group first seen on December 30th, somewhat protean in its character. The leader was single and the trailer double. On the 31st the leader was at first double, and later a chain of four pores, whilst the trailer was solitary, with a disturbed area between them. On January 1st the leader was at first like a spot with two umbrae, but the western one soon disappeared, a few pores being close by; the eastern spotlet now only a pore. On the 2nd the trailer

The second diagram shows the distribution of spot disturbances through the year. The falling-off as compared with 1912 is very marked, as will be seen on reference to page 69 of our last volume. Another striking difference is that the mean latitude of the outbreaks is now so much farther removed from the Equator. In 1912 the majority of the spots were south of the Equator; in 1913 the numbers north and south are almost equal, the former being one to the good. The gathering of the outbreaks into groups, which has been so marked in previous years, is in this barely noticeable. There seems to be little doubt that the minimum has now been passed. Observations were made on three hundred and forty-three days, spots being visible on seventy-six, faculae only on one hundred and fifteen, whilst on the remaining one hundred and fifty-two the disc appeared free from disturbance.

Our monthly chart has been constructed from the combined observations of Messrs. J. McHarg, C. P. Frooms, and F. C. Dennett.

DISTRIBUTION OF SPOT-DISTURBANCES DURING 1913.



NOTICES.

THE SOCIÉTÉ GENEVOISE.—Mr. O. Paul Monckton, M.A., A.M.I.C.E., of 87, Victoria Street, S.W., has been appointed sole agent for Great Britain by the Société Genevoise which, besides making the line standards of length used in the National Physical Laboratory, manufactures dividing engines and machines for grinding gauges.

ALCHEMY AND THE KABALAH.—At a meeting of the Alchemical Society held on January 9th, Mr. Arthnr Waite lectured on "Kabalistic Alchemy," and made a very successful attempt to fix the approximate date of the Hebrew work known as *Aesh metzareph* the "Book of the Refining Fire" which survives only in the Latin Lexicon of Baron von Rosenroth.

ALLEN'S COMMERCIAL ORGANIC ANALYSIS.—The eighth volume of the new edition of Allen's Commercial Organic Analysis which Messrs. J. & A. Churchill are bringing out is now ready for publication. The subjects considered are enzymes, proteins of all kinds, milk and meat products, haemoglobin and its derivatives, and fibroids, each of which has been dealt with by an expert.

A BIRD SANCTUARY FOR BRIGHTON.—The Mayor of Brighton, Alderman J. L. Otter, when presiding at a lecture on the Brent Valley Bird Sanctuary, given in the Public Museum, made the statement that nothing would give him greater pleasure than that his year of office should be marked by the establishment of a bird sanctuary at Brighton. There will be some difficulty, no doubt, in getting the necessary land, but we hope that this may not be found insurmountable.

BAD GERMINATION OF WHEAT SEED.—A sample of wheat which was examined at Kew because its germinating power was not above fifty per cent. was found to contain, in the chaff, the fungus *Cladosporium graminum*. So soon as the grains began to germinate the fungus started growth also and in the seedlings which died it was invariably found that the embryo was permeated by the mycelium of the fungus, while none was discovered in the seeds that germinated successfully and continued to grow vigorously.

THE LONDON NATURAL HISTORY SOCIETY.—The City of London Entomological and the North London Natural History Societies have now amalgamated to form the London Natural History Society under the presidency of Mr. L. B. Prout, F.E.S. A very successful meeting was held on January 6th, and the new society starts with two hundred and fifty members and associates. There are two branches (at Chingford and Woodford) and three secretaries, Messrs. T. R. Brooke, F.R.M.S., 12, Warren Road, Chingford; J. Ross, 18, Queen's Grove Road, Chingford; and H. B. Williams, LL.B., 82, Filey Avenue, Stoke Newington.

FLAX-GROWING IN ENGLAND.—Corn-growing has almost entirely ousted flax from England and so long ago as 1895 Mr. David Houston (*Biology Notes*, 1895) suggested that it might be cultivated again in Essex. Now we have before us a report (issued as a supplement to *The Journal of the Board of Agriculture* for January, 1914) dealing very fully with the possibility of reviving the flax industry in Great Britian. Botanists will find the historical review of interest, and the conclusions at which the compiler, Dr. J. Vargas Eyre, arrives are that, as the climate and soil of this country are suited to flax, the industry might, if managed according to improved methods, benefit British Agriculture; the plants being grown primarily as a fibre crop while at the same time the seed could be saved.

NEWTON & COMPANY'S LANTERN SLIDES.—Messrs. Newton & Company have sent for review the second part of their catalogue of lantern slides which extends to nearly six hundred pages, and we learn that its production cost more than one thousand pounds. Its object is to supply the enormously increased demand for lantern slides in schools, and in this connection Messrs. Newton, on page 901 of the catalogue, describe new school lanterns specially adapted for class work. There is an excellent index and six main subjects can be referred to instantly as the margins are cut down to the first page in each case so that the thumb may be inserted at the right place. Messrs. Newton are to be congratulated on the publication of the sets of lantern slides compiled by the Visual Instruction Committee of the Colonial Office and the Committee of London Teachers of Geography.

THE ROYAL ANTHROPOLOGICAL INSTITUTE.—At the annual meeting of the Royal Anthropological Institute, on January 20th, the President, Professor Keith gave an address on the "Reconstruction of Human Fossil Skulls." The lecturer maintained that the ordinary anthropological methods, which were employed for the examination and description of complete skulls were not applicable to fragmentary fossil skulls. During the last six years he had endeavoured to discover and perfect methods which might be employed in the reconstruction of skulls from fragments. Recently fragments of a human skull, representative of the pieces of a fossil human skull found at Piltdown, had been submitted to him for reconstruction. A cast of the original skull was kept by those who submitted the fragments to him. There was no apparent trace on the fragments of the middle line along the vault. The reconstructed skull, with a cast of the original, was submitted to the meeting.

CAN SELECTION IMPROVE THE QUALITY OF A PURE STRAIN OF PLANTS?—The claim of seed merchants that continued selection gradually improves varieties of plants, and that it is indispensable to keep up their quality, is examined by Messrs. C. and A. Hagedoorn in *The Journal of the Board of Agriculture* for January, 1914. The conclusion arrived at is that the seed of self-fertilised plants, which has been derived from one single plant of a pure strain by some generations of multiplication, is as good after ten or twenty generations as it was when it left the seed merchant.

The evidence brought forward in support of this opinion is very interesting. Between 1840 and 1850 Louis de Vilmorin started growing different varieties of wheat, and he kept an ear of every kind, with its name and date. The collection has been added to and the varieties are still grown by Vilmorin's son and grandson. Ears grown in the year 1911 have been photographed side by side with others from the original plants put by before the year 1850 and when a comparison is made no appreciable difference can be detected.

It must be added that if a seed merchant, however, sells a mixture in which some seeds—even a small minority—belong to a strain which does not come up to the standard, the seed cannot be multiplied indefinitely, for there is the risk that the plants of the inferior strain may take the upper hand. The authors think that there is really no excuse at the present day for merchants to sell anything but seed of absolute purity.

In habitually cross-fertilised plants such as rye and beet a continued selection by experts is most necessary, as under practical conditions no really pure strain can ever be produced by such plants. It is this fact that very probably has caused the unwarranted generalisation that the same holds good in the case of all agricultural plants.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

MARCH, 1914.

COMMENTS.

THE PUBLIC UTILITY OF MUSEUMS.—On January 31st Lord Sudeley gave an address to teachers under the auspices of the Education Committee of the London County Council.

It will be remembered that Lord Sudeley has for some time very strenuously advocated the employment of guide-demonstrators in public museums, and in his address he was able to give figures which showed that the interest taken by the public in institutions where they can avail themselves of the services of a guide has enormously increased. Members of natural history societies who have spent an afternoon in a museum with one of the staff to explain matters will know what a difference it makes to have someone at hand who is really conversant with what the specimens are and what they show.

We sincerely hope that Lord Sudeley will continue to press for the appointment of guides in institutions of all kinds of an educational character.

In the address a good deal was said about the taking of children to museums by their teachers. We know from experience that some teachers could do a very great deal when acting as guides, and that all could do something. But we think that the most successful guide would be one who had much greater opportunities of familiarising himself with the collections or who has actually arranged and labelled them.

We are not sanguine of teachers finding a new profession as guide-demonstrators, and we rather think that it is good for children sometimes to listen to words from a person who is not their regular instructor.

We would like to remind our readers that Lord Sudeley has hitherto interested himself in museums intended for the general public. There is another important aspect of the subject, and that is the establishment of special museums or collections intended primarily for children. An article in which this is dealt with appears on page 89 of the present number.

Mr. John W. Gilbert, the Chairman of the London Education Committee, on the occasion of Lord Sudeley's address, mentioned the enormous number of children in London, and the difficulties of arranging for sufficiently small numbers to go on the journeys, which are often exceedingly long. It is surprising that the alternative of taking specimens to the children, which has been carried out with success in some localities, has not been developed much further. Remarks on this also will be found in the article already mentioned.

THE PLUMAGE QUESTION.—Mr. S. L. Bensusan, who is one of the Honorary Secretaries of the Committee for the Economic Preservation of Birds, on February 16th, gave a very telling account of the plumage question, and of the successful attempts which his Committee has made really to do something at last which will protect birds from extinction.

Repeated attempts have been made to obtain legislation which will prevent the importation of certain feathers into this country. These have not been successful. In cases where laws have been passed, as in Australia and India, valuable plumage is still sent out of the country under the rose.

The latest Bill introduced into Parliament prohibits the importation of all feathers except

the plumage of the ostrich and eiderdown. If such an one becomes law it merely means that the goods heretofore consigned to England will go to France, for that country will not follow suit with a similar prohibition, and there are many other European countries which would have to be won over if it did.

The Committee for the Economic Preservation of Birds has begun, with the concerted help of the trade representatives in London, Paris, Berlin, and Vienna, to make a list of birds in which the merchants and brokers will no longer deal. Surely this is the commonsense method which should appeal to everyone who does not allow sentiment to run away with them; and, as Dr. Chalmers Mitchell, the Chairman of the Committee, said, those who seek to protect birds in another way should not attribute motives to those who work differently.

We noted in our September issue, 1913, that through the action of the Selborne Society the Committee for the Economic Preservation of Birds came into existence, and now that the representative members of that Society have made a report, the Council has unanimously resolved that, "while not departing in any way from its policy of discouraging the wearing of plumage, is of opinion that its object of preserving birds which are harmless, beautiful, or rare, may for the present be best accomplished by such international arrangements as are being made by the Committee for the Economic Preservation of Birds."

The report which appears in the current number of *The Selborne Magazine* is as follows:—

The members representing the Council of the Selborne Society on the Committee for the Economic Preservation of Birds have pleasure in reporting that the attempt which the Committee has made to bring about the protection of birds by means of international agreement on the part of the plume trade has been most successful.

In the first place a German Committee for the Economic Preservation of Birds has been established in Berlin, and has adopted the programme of the London Committee in its entirety. Professor Reichenow and Dr. Heinroth are among the German ornithologists who have joined the Berlin Committee.

A French Committee has been brought into existence, of which the French Minister of Commerce has become the Honorary President, while the French merchants, through the presidents of their Intersyndical Chambers, have formally agreed to accept the findings of the London Committee, and have themselves suggested certain birds which they think should be protected.

The merchants of Vienna, through their Chamber of Commerce, have undertaken, in writing, to accept the findings of the London Committee.

The leading London merchants and brokers have signed a like undertaking.

At a meeting, held on December 15th, 1913, the following birds were put on the protected list:—

The family of Cotingidae (Chatterers).
The Resplendent, or Longtailed Trogon.
The Lyre Bird, }
The Rifle Bird, } of Australia.
The Regent Bird, }

At a meeting on January 26th, 1914, the Flamingo and the Spoonbills were added to the list, while, on February 9th, the Cattle-Egret, of India, was recommended for protection as well as a number of birds found to be useful to agriculture in France.

The Australian birds and the Indian Egret, abovementioned, by law are not allowed to be exported, but they continue to be smuggled out and brought to this country; hence the action of the Committee. Other birds are being considered, and evidence is being collected with regard to the plumage question from all parts of the world.

LONDON PARKS.—*The Gardener's Chronicle* has a spirited protest against the cutting down of trees in London Parks in order to make way for the playing of children's games. The suggestion has been very rightly put forward that grown-up people who wish to take advantage of the small amount of rusticity to be found in the Metropolis should be considered, and it is to be hoped that if the abuses which *The Gardener's Chronicle* outlines exist, the residents in the neighbourhoods of the parks which are likely to be damaged will unite and take action.

THE SOCIETY FOR THE PROMOTION OF NATURE RESERVES.—Our readers will remember the articles which Mr. William Rowan has written in these pages on the bird-life of Blakeney Point, which has been secured through the action of the Society for the Promotion of Nature Reserves. Our review of *The Journal of Ecology* on page 105 will also show the advantage which scientific men and students are taking of their opportunities at Blakeney. We therefore should like to emphasise the need which exists of supporting the Society in question.

It in no way interferes with the objects of any other existing society, and any tracts of land which it is able to preserve it hands over to the care of the National Trust. Its President is the Speaker, the Rt. Hon. J. W. Lowther, and among the Council are Dr. Bailey Balfour, Sir Francis Darwin, Mr. G. Claridge Druce, Professor Farmer, Sir Edward Grey, Mr. L. V. Harcourt, Mr. E. S. Montagu, Professor Poulton, Sir David Prain, and Mr. Charles Rothschild.

The first object of the Society is to collect and collate information as to areas of land in the United Kingdom which retain their primitive condition, and contain rare and local species liable to extinction owing to building, drainage, and disafforestation, or in consequence of the cupidity of collectors. Furthermore, the intention is to obtain some of these areas if possible and to preserve for posterity as a national possession some part at least of our native land, its fauna, flora, and geological features. Lastly, the Society exists to encourage the love of nature, and to educate public opinion to a better knowledge of nature study.

Any information which is given to the Society will be treated as strictly confidential, and details as to any suitable reserves should be sent on one of the red forms, which, with information as how to help on the work, may be obtained from the Honorary Secretaries, Mr. W. R. Ogilvie-Grant, and the Hon. F. R. Hendley, Care of the British Museum (Natural History), Cromwell Road, London, S.W.

STELLAR SPECTROSCOPY FOR BEGINNERS. V.

By PROFESSOR A. W. BICKERTON, A.R.S.M.

A LARGE part of the work of the astrophysicist is associated with spectrograms, and it is said there are not a dozen astrophysicists altogether. Perhaps this is true, for doubtless an astrophysicist should be a physicist first and then an astronomer. Essentially he needs to know, extraordinarily well, molecular physics and thermodynamics, theoretical optics and the dynamical theory of gases. His experience in the work of the professional astronomer of the past may be of the slightest. The tremendous bound forward of modern astronomy has been almost wholly the work of astrophysicists. Hence it is highly desirable that a greater knowledge of the basic principles on which the progress of this new science depends should be widely known and its scattered workers all over the world be brought into touch. We want an International Astrophysical Society.

A large part of Astrophysics involves problems relating to energy.

ENERGY.

In this article we are dealing with the vibrations of atoms and their speed in space; and both are questions of energy. Energy is the capacity for doing work: it is of two kinds, kinetic and potential; that is, the energy of motion and of position or of strain. Energy of position is of as many kinds as there are physical forces. Objects removed under the stress of attraction, or brought together against the stress of repulsion, acquire potential energy. Lift a brick on to a tower and it then possesses potential energy; let it drop and the energy of position becomes energy of motion, and the working power of the motion of the whole brick (its mass motion) is called molar kinetic energy (from Latin *moles*, a mass). When it falls on the pavement the shock causes it to quiver internally; the motion becomes molecular and atomic, and this kind of indiscriminate quiver we call heat, or molecular kinetic energy.

Hot things radiate, and radiation appears to be this internal atomic or molecular motion communicated to the ether. It is convenient to regard the ether as an all-prevailing elastic jelly-like solid. The more we know of radiation, the more difficult it becomes to grasp the full character of the ether. As its vibrations can be transverse, it seems best to think of it as a jelly of extreme elasticity that is very incompressible. The ether communicates its vibrations to the hand as warmth, and to the eye as light. Students of spectroscopy must carefully differentiate between molar motion and molecular heat motion, especially in gases. Important stellar problems have been left unsolved by astronomers for lack of this differentiation. Wind is molar motion of gas; the heat of a flame is atomic and molecular motion. The upward motion of a flame is molar motion.

ATOMIC VIBRATIONS.

For the last forty years I have pictured an atom as a nucleus with an elastic electrically non-conductive exterior, and the more we know of the structure of atoms the better the idea seems to hold. When atoms are struck they vibrate, and the sharper the blow, the more overtones seem to be produced. We can give velocity to atoms by heat and by electricity; in stellar space atoms also acquire velocity by the attraction of gravitation. The higher the potential of electricity, and the greater the temperature at which atoms strike, the faster is the internal vibration produced, and the higher the pitch of the overtones. We have already discussed the complex characters of the varied series of the overtones of atoms of different elements.

The more frequent the luminous vibrations are, the further they appear toward the ultra-violet end of the spectrum. The luminous influence of temperature, as already mentioned, is perhaps best shown by having a thin upright heated platinum wire, and viewing it through a prism in a card at a long distance away (see Figure 62). Pass a current through the wire and bring it to a low, red heat; then keep lessening the electrical resistance of the circuit; the current increases, and the wire gets hotter. As it does so the red patch of light seen through the prism extends progressively towards the violet, adding orange, yellow, green, blue, and indigo, until it becomes a full and beautiful spectrum. When it is red there is very little light; the thermal radiation is then some hundred of times greater than the luminous. As the temperature rises the ratio of light to heat increases until we get sunlight with half the radiant energy luminous. Hence a very high temperature produces a cool light. To illustrate, compare the radiant energy from a glowing fire and an "Osram" lamp. On switching off the lamp the room is dark, yet one does not notice any difference in the warmth. As the temperature rises the light becomes whiter. Compare a candle with a carbon incandescent burner, and it looks yellow; in its turn the carbon looks yellow beside the metal filament, and this looks yellow beside an arc light. The whitest light is the electric spark from a Leyden jar, and this is the means of producing a spectrum that seems to indicate that the atoms have been shaken more than by any other method.

We are justified in thinking that the closer atoms get to the solar and stellar photospheres the hotter

they become, and the higher the overtones that are produced. This shows beautifully in the enlargement of the Worthington spectrogram in the December number of "KNOWLEDGE." All the lower hydrogen overtones are perfect rings, because they extend high in the chromosphere. But the quick overtones, as we go towards the violet end, are only segments of circles, getting shorter and shorter. This shows that these high overtones were only produced by atoms near the photosphere. It also gives an idea of the stupendous temperature of the stars in which the hydrogen bands can be traced far beyond the Omega line.

Just as it is possible to strike a tuning-fork or a bell with a small hard object, and get sharp overtones and yet scarcely hear the lower tones at all, so it seems to be the case with atoms. By different modes of exciting atoms quite different spectra are produced; the lowest kind is by a spirit-lamp, next the bunsen burner, then the hot-blast blowpipe, and the highest temperature of all is the electric arc. But when electricity is used the effect is mixed. Doubtless, as I showed in *The Philosophical Magazine* some forty years ago, the blow an atom gets may be due to heat, or to electricity, or to both combined. Of electrical methods we have the ordinary vacuum tube with capillary neck, the ordinary electric arc, the spark, and the spark intensified by a Leyden jar. Then the degree of exhaustion—that is, the pressure—also influences the kind of spectrum, the width of bands, and so on.

DISPLACEMENT AND BROADENING OF LINES, AND REVERSION.

We have now treated of the excitation of the atom and its complex overtones; we shall discuss a little more fully some of the effects of other physical agencies upon the radiation that has been produced. These agencies are of two chief kinds, the effect of the relative motion in space, either of the observer or the singing atoms, and the effect of the absorption by atoms of radiant energy. We shall take relative motion in space first.

INFLUENCE OF RELATIVE MOTION.

The idea of Doppler's principle was based on a somewhat exaggerated notion, so far as the facts it was intended to explain were concerned. But the detection of new principles is rare enough; we cannot afford to waste this gold of thought because it contains earthy gangue, and is not yet minted into the current coin of science. It is very important that scientific men should separate the nuggets of golden thought from the spurious mundic of error, and not put a hall-mark upon counterfeit coin. But the way human progress has been retarded by the inhospitality of officials towards new generalisations is nothing short of a world tragedy.

This inhospitality has been not merely against new theories, but against new correlations based on rational new scientific principles, founded on scientific laws, and attested by many facts. Also they have slept even when the anticipating deductions have been backed up by the most striking observational evidence. Sir Ronald Ross has attacked this lethargy in the current number of *Science Progress* in a most masterly article.

DOPPLER'S PRINCIPLE.

The principle is that a vibrating body giving off waves has those waves closed up (that is, the waves become shorter and the pitch increases) if the body is approaching; and has its waves opened out and the pitch becomes lower if it is receding, and the distance between the vibrating object and the observer is increasing. Doppler appears to have discovered this principle when trying to explain the colours of stars. He seems to have imagined that the luminous vibrations of stars had definite limits of wave-length, which the work we have already studied shows to be to some extent true.

Distinctly stars have a tint. He thought that if stars were approaching us they would have a blue tint, and if receding a red tint. We now know that blue stars may be going away, and red stars may be approaching. Any given pure tint is altered either towards the red or the violet, but with the ordinary velocity of stars a general change of colour could not be detected. Although founded on a great exaggeration, yet this idea of change of wave-length is one of the most important principles of spectroscopy. Lord Rayleigh thinks it very far-reaching in explanation, and I certainly agree with him.

Fortunately Doppler's principle was seen to be true, and has been used to explain almost endless phenomena. If mankind had been as ready to reject metals because of the gangue as we are to neglect correlation containing much truth because there is some error we should still be in the Stone age. What we want is a kind of scientific court of claims where a new generalisation could be investigated; a solitary worker is very liable, amidst much truth, to overestimate a principle; and effects may creep in that exaggerate a phenomenon. In my description of the well-known change of pitch in passing trains I must have mixed two agencies. I find on calculating the effect of two trains, each passing at about a mile a minute, the drop of the note would be less than an octave. When the whistling train passed us the flattening unconsciously struck me, but the very low note that followed was not the whistle—it was merely the rumble of the passing train. Since I made the calculation I have not passed a whistling train, but have passed trains and noticed that their rumble has a kind of rough pitch. Most people's ears have been trained by listening to good music, so that even a very slight flattening of a note is quite perceptible.

A given spectral line is simply displaced by the movement of the star, or other luminous body, towards or away from us; but if the atoms of a

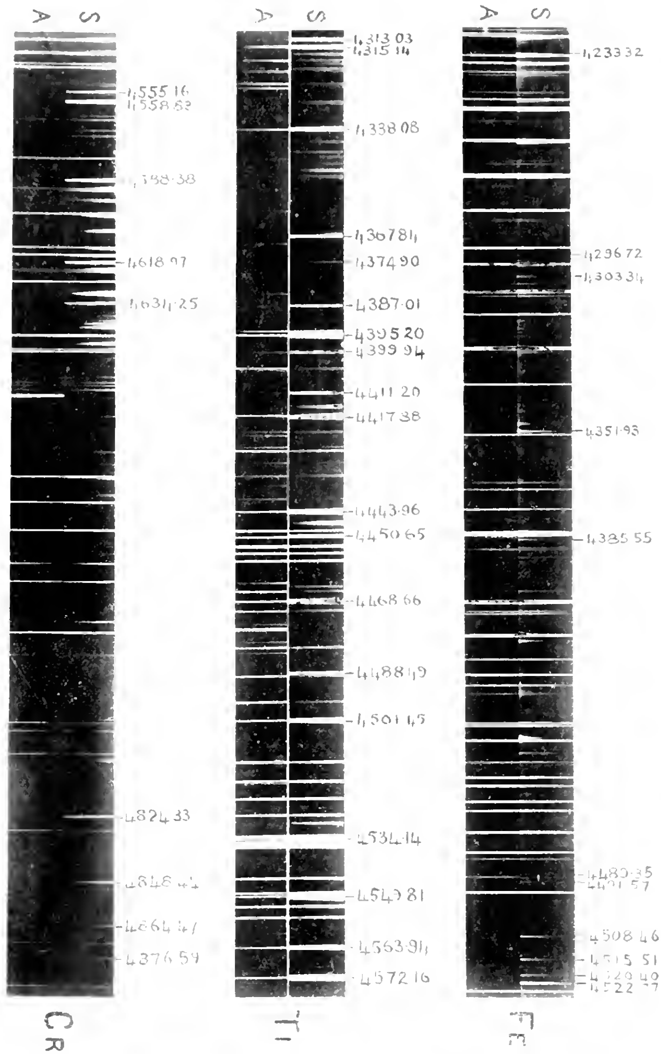
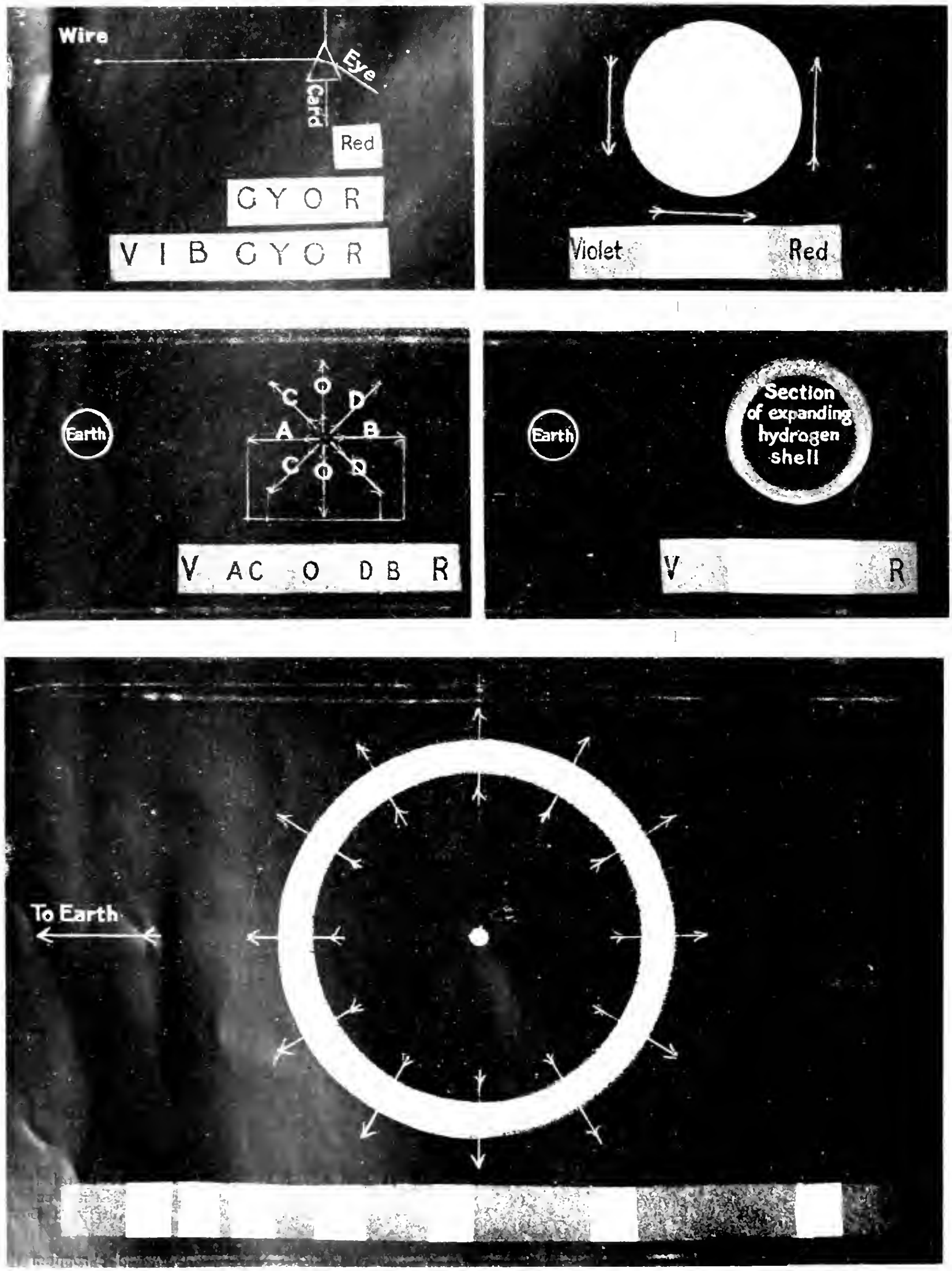


FIGURE 1.

The two spectra of iron and titanium lie between wave-lengths 4313 and 4572: [illegible] between 4530 and 4876. In each case a very little piece of the whole spectrum is shown, [illegible] more than a twentieth. The series is a remarkable illustration of the beautiful work that was done at the Solar Physics Laboratory at South Kensington.

In the spark spectrum of iron (Fe), the pole is shown at the bottom; in the [illegible] titanium and chromium the spark pole is at the top.


Wire
Eye
Card
Red
G Y O R
V I B G Y O R
Violet
Red
Earth
C
O
D
A
B
C
O
D
V AC O DB R
Earth
Section of expanding hydrogen shell
V
R
To Earth

body are moving in all directions the line broadens and becomes a band, even when we use a narrow slit. The width of a band does not indicate the distance travelled by an atom, it only shows its maximum speed. The atmosphere of a star that produces broad bands may have no convection currents; the atoms may simply be vibrating, due to heat. The average width of the bands of many pre-solar stars seems to indicate that the speed attained by the hydrogen atoms is something like two hundred miles a second each way. In Nova Persei the displacement of the black band and the widening of the bright bands indicated a speed of about one thousand miles a second. The temperature varies as the square of the velocity. So, if the widening of the bands in this temporary star was originally due to heat, its temperature must have been about twenty-five times as high as that of a pre-solar star.

In my article on the Sun ("Knowledge," February, 1912) I showed that the photosphere was probably due to the mixed elements of the Sun having a definite surface of statical equilibrium. The fact that the spectra of pre-solar stars give black hydrogen bands shows that they have a photosphere shining through a cooler atmosphere and seems to suggest that these stars have the same structure. As it is easier to understand the bright lines of emission than the dark lines of absorption, so it is easier to understand the bright bands of hydrogen seen in novae than the dark bands of stars. We shall try to understand the bands of temporary stars before those of the Sirian stars.

The Bright Bands of Novae.

Novae, or temporary stars, are brilliant stars that appear suddenly in the heavens: at birth they may be some thousands of times the intensity of the Sun. They quickly increase in luminosity until in some cases they are scores of thousands of times more brilliant than our ruling orb. They then fade too rapidly for ordinary cooling to account for, and generally for a time become planetary nebulae.

In the past they have been the enigmas of astronomy, but the account of their origin given in "Knowledge" (September, 1911) agrees so absolutely with all their characters as to be a satisfactory explanation of their genesis.

Novae are the third stars torn from partially colliding suns. Stellar flint and steel have grazed each other, and struck off a cosmic spark of stupendous brilliancy and wide astronomic potentiality.

Wonderful as are the series of phenomena of novae, yet they are all so singularly alike as to be able to be divided into six criteria, any one of which is explained in every detail by the theory of the third star; and no other theory of their origin fully explains one of the six.

The new star has taken so much energy of the collision of its gigantic parents as to be an exploding sun. It possesses a curious tendency to sort its atoms, so that they tend to expand in a series of ensphering shells with the lightest element, hydrogen outside. Gaseous adhesion carries other elements with it to some extent. The speed of expansion of this shell is many times its critical velocity; that is, the gravitation of the new star will never stop the rapidly moving hydrogen atoms. As the phenomenon of novae is largely made up of the behaviour of hydrogen, we shall at first, for simplicity, treat of the bright bands of hydrogen alone. We shall take its black bands and other spectral phenomena after we have studied the phenomenon of reversion.

Let us imagine a vast shell of the luminous hydrogen expanding in all directions (see Figure 66). It is so far away that it appears to be a mere point of light. The ring represents a section of the expanding sphere of gas. It is of the character of a radial wind. Notice that the motion of expansion is molar motion, but there is also intense indiscriminate motion of heat that makes the atoms strike one another and produce an internal quiver that causes luminosity. In the vast expanding hollow spheres the atoms nearest us are advancing; the atoms on the far side are receding. Let us first study isolated groups of atoms (see Figure 64). Let E be the Earth and V–R the spectrum of a single overtone. A will be the atoms coming our way, B those receding; the atoms travelling right and left are not displaced, as they keep the same distance. A, coming directly towards us, is most displaced towards the violet; B, going away, is most displaced towards the red; C is resolved in our direction and displaced towards V, and D is resolved away and displaced towards R. So we have a series of lines. Fill in the intermediate spaces as in Figure 65, and then imagine the whole a radial mass of moving atoms, as they are, and the whole space becomes a band. Do the same for all the overtones as in Figure 66, and we have the exact effect of a late stage of all novae. Thus easily is explained the broad, bright bands of new stars. Explanations of every other detail of the extraordinary sequence of spectrograms that novae develop are fully explained as we trace the multiple phenomena of the complex third body struck from grazing stars or dead suns.

If the series of hydrogen bands of the stars of Secchi's first type is caused by heat, each atom is vibrating internally and producing the overtones, and also moving in all directions in a series of short, free paths. In the novae we saw the different atoms travelling in regular radial paths. In this case we have to imagine that each atom successively travels in all directions, and so displaces its lines on both sides of the normal position.

There is still another way in which lines may be broadened into bands, and that is, if a star were rapidly rotating and the equator were edge on to us, on one side the star is approaching, on the other it is retreating (see Figure 63); so the lines would broaden. But if this were the case with pre-solar

stars there would be no thin lines, but these are seen beautifully in Figure 423 "KNOWLEDGE," Vol. XXXVI (November, 1913).

These thin, dark lines indicate comparatively cool gases in the outer region of the star's atmosphere; but of black absorption lines we shall treat in the next article.

Each of these three modes of the broadening of bands must be considered when trying to solve the problem of complex stars. We have hinted at quite intelligible solutions of some of the so-called "enigmas" of spectra, and we shall find that most others find solutions if only we attack them aright.

If we imagine an atom to be a kind of flying spherical bell that rings and vibrates when it is struck, and that some notes last some distance as the atom travels and others die out quickly, it will give an idea of the meaning of the long and short lines of the spectrum. If some elements in an electric arc or spark be focused so as to cover the exact length of the slit of a spectroscope, some lines reach across and some do not. Figure 61 shows the difference in this respect between the electric arc and the induction coil intensified by a Leyden jar. In these beautiful spectra the images have been thrown on the slit in a direction parallel to the flames, and in each case only one half has fallen on the slit, so that one of the poles shows along one edge of each spectrogram. All these spectra, but especially those from the spark-jar, show in a striking way the difference in the duration of the atomic overtones as seen in these long and short lines, some reaching from pole to pole, others only a small fraction of the distance. Although some of the lines of each element are the same in the two different spectra, yet, taking it all together, they show a great difference in the way the atom is disturbed when the vibrations are produced by the electric arc and by the tremendous shock of the spark-jar.

It is believed by some workers that some atoms are broken up by the shock of the condensed spark, and that some of the lines belong to the fragments; and the same fracture happens in many stars. This is a line of research that is worthy of much more patient work, although a good deal has already been done in this direction. What is now wanted is correlation between the wonderful revelations made by researches in radium phenomena and those made in connection with high-intensity spark spectra and spectrograms that show similar lines. We appear to be on the threshold of great and important revelations regarding the constitution of matter. It is clear that the problem has to be attacked both from the wide cosmic and the minute electron standpoint. It is certain we have higher temperatures and more stupendous forces at work in the crucibles of cosmic space than are possible in any laboratory experiments. Consequently the true interpretation of spectrograms is probably the most important scientific problem of the present day.

CORRESPONDENCE.

HIGH TIDE AT FREEMANTLE.

To the Editors of "KNOWLEDGE."

SIRS,—Could you inform me why there is only one daily high tide at Freemantle instead of the usual two, or give me reference to a source from which I could get the required information?

W. GORNOLD, F.A.S.

SOUTH KENSINGTON, S.W.

GINKGO BILOBA.

To the Editors of "KNOWLEDGE."

SIRS,—My attention has just been drawn to the plate of *Ginkgo biloba* in the January issue of "KNOWLEDGE." The tree as represented in this plate has not the characteristic form, and can only be regarded as an imperfect and inferior specimen. There are two specimens at Cobham Hall, near Rochester, incomparably superior to the Kew specimen, and at least one-third larger. It is a tree which only attains its characteristic habit at a considerable age. The Cobham specimens are about a century old and present a noble aspect with semi-drooping habit and long branches sweeping the ground.

"HURSTCOT."

CHATHAM.

THE FREEZING OF WATER.

To the Editors of "KNOWLEDGE."

SIRS,—It is often asserted that, given two masses of water, the one at the higher initial temperature will freeze first. I am wondering if this theory is classed among popular fallacies.

At first sight, of course, the theory seems absurd. Water has its maximum density at 4° C and thus all the water in a pond must sink to this temperature before freezing. It follows that, in considering two ponds under equally exposed conditions, the subject might be discussed under three heads:

(1) Initial temperature of both ponds above 4° C.

(2) Initial temperature of one above 4°, but that of the other below.

(3) Initial temperature of both below 4° C.

With regard to case (1) it is only necessary to consider the conditions down to 4° C since below this temperature they must be the same for the reason stated above. The pond at the lower temperature of say 10° C, will take t hours to fall to 4° C, and the pond at say 30° C will take T hours to fall from 30° C to 10° C. In falling from 10° to 4° it will take presumably the same time as the other pond, *i.e.* t hours. Thus one pond occupies t hours and the other $(t+T)$ hours. Mean temperatures are referred to. If the theory is wrong where does the fallacy come in?

The above seems logical, but I have some evidence which certainly seems to bear out the first theory. A lake near Crediton, in Devonshire, narrows considerably in the middle, practically making two lakes. They are not very exposed, being surrounded by trees; but one lake is fed by a hot spring: this lake is always *the first to freeze in winter.*

I should be very glad to hear the opinions of your readers on this point.

C. H. E. RIDPATH.

210, ADELAIDE ROAD,
SOUTH HAMPSTEAD.

MUSEUMS AND EDUCATION.

By WILFRED MARK WEBB, F.L.S.

The question of utilising museums in education is not a new one, but the success which has attended the appointment of guide-demonstrators in some of our National Institutions and the fact that there is a Committee of the British Association considering the matter make it one of interest at the present moment.

Lord Sudeley is the great advocate of using museums to a larger extent, and in a recent address which he gave he had a good deal to say with regard to the taking of children to museums. A point worthy of consideration is whether the collections shown in our great institutions are meant for the use of children; and although they may be very valuable, nevertheless, in the absence of anything else, might it not be even a better plan to have museums, or at least exhibits, which are arranged and intended for young people?

There are a number of practical details which should come in for consideration. There is the height of the cases, the amount of material displayed, the wording of the labels, not to mention the particular specimens which might be specially chosen with a view to exciting the interest of children.

Now in utilising museums in general education it is possible, as has already been said, to prepare special exhibits for young people which could be kept in a children's room, set apart for the purpose, in existing institutions; or museums could be inaugurated especially for children; while in the third place—and this becomes almost a necessity in great cities—the museum could be taken to the child by having a series of specimens which travel the round of the schools.

The whole subject is one which must be approached in a broad spirit. It is not one with which the curator alone should deal; he may be in a groove and know nothing of teaching. The educationist might offer useful suggestions; the teacher could give information about the capacity and needs of his pupils; and it would be well not to ignore the advantage of having someone to write the labels who knows how to put the matter before people in print, so that they may be tempted to read it. The present writer has taken some interest in education, especially where things rather than books are concerned; he has been a schoolmaster, is acting as a museum curator, and at one time earned his living by writing for the Press. He has therefore been tempted to make some remarks in regard to museums as aids to teaching and to put down on paper some ideas with regard to the planning-out of a children's museum.

Turning first of all to the question of a demonstration in the case of existing collections. The first requirement of the guide is that he should know the museum thoroughly. He should be aware of the reason why each specimen has been chosen and all that it shows. In a small institution it might be possible for the curator or one of his assistants to do the demonstrating, and nothing could be better than that the man who carried out the work should explain it. Unfortunately many museums are very much understaffed. In larger institutions guide-demonstrators would devote their whole time to describing the collections, and would be chosen for their wide knowledge. It is quite possible, though we do not think it is the ideal arrangement, for the children's own teacher to take them round the museum. We can see the advantage if the object of the visit be to illustrate some particular lesson which the teacher has given or has in mind, and he can judge better the capacity of his pupils to benefit by what they hear and see. One cannot help thinking, however, that it is an advantage for children to be taught occasionally by someone to whom they are not accustomed, and to come into contact with another personality. The teacher should always be at hand, so that reference can be made to him or to her, and discipline, if necessary, be maintained.

It is all very well to say that museums are not as useful as they might be, but we have to remember the objects which they fulfil, quite apart from the question at issue. We take it that, first of all, a museum is to educate those members of the general public who feel inclined to take advantage of it. It fills the place of a textbook, more or less simple, in which the pictures are replaced by the things themselves. A great advantage is that it preserves many objects which would otherwise be lost, or scattered about in private collections—where they could not be severally seen—things that are no longer used, animals which have become extinct, and so on, as the case may be. To be of any great value or importance a museum should be a place of reference, though the collections intended for scientific students and specialists need not be displayed. Works of art, however, will generally be on view, though we are all familiar with the arrangements whereby galleries of pictures and sculpture may be closed to the public on students' days.

We may return now for a moment to the personal explanation of the contents of museums. Just as it would be possible for a very pleasing lecture or a most attractive article to be culled from a textbook, so the guide-demonstrator can tell a story about the specimens which arouses interest, and even enthusiasm, on the part of his hearers. For this

reason the appointment of such an official in all public institutions is most strongly to be urged.

It is not, however, the bigger museums that we wish particularly to consider here. The collections contained in them are so extensive that our remarks would hardly apply to them except as regards a room specially arranged for children, should one be instituted. We are fully aware of the difficulty of adapting old institutions to new purposes, and we would prefer to discuss the formation of a small museum intended to be educational in the best sense of the word.

To begin with we shall leave on one side art and history and deal with the natural environment of the child; but before going into detail it will be necessary to emphasise the point that, if it is to be thoroughly successful, a museum of whatsoever kind must be made to *appear*, as well as to *be*, interesting. Moreover, it is just as important that what is on view should attract, not only during the first or second visit, but also on any subsequent occasion. If the museum is to be for children it is imperative to have exhibits which appeal to them. Care should be taken that there be no overcrowding of specimens, and that there be not too much in one place to be appreciated at any one time, while it must not be forgotten that the cases should be of a height suitable to the stature of the visitors for whom the exhibits within are intended.

In the case of a small museum, if interest is to be sustained, the only plan seems to be to introduce a very definite system of changing what is on view. At this point it may be mentioned that it is now becoming recognised that there is no necessity for everything in a museum to be dead. Already, in a number of modern institutions, there is a living side, even if it only amounts to a series of the common wild flowers which are to be found in bloom during the month. Here we find introduced at the same time a specially attractive feature and the element of change. A very good suggestion recently made during a discussion at the Birmingham Meeting of the British Association was that specimens should be provided which the visitors could actually handle. This, again, would be an additional source of interest, though care would have to be taken to choose material which could not easily be damaged, or at any rate be replaced without any difficulty. It has occurred to the present writer that it would be interesting to him and possibly useful to others if he were to show, by actual exhibits, his idea of what a children's museum should be. He therefore suggested to the promoters of the Children's Welfare Exhibition that space might be found at their Exhibition for "A Children's Museum." As they agreed to the suggestion, the exhibits are being prepared, and a scheme is given here showing what it is intended to illustrate as a whole or in part.

Nowadays, when speaking of teaching, particularly in connection with natural objects, it is advisable to differentiate between that which is didactic, and is concerned with the giving of information to the pupil, and that typified by Nature Study (using the words in a technical sense), which leads the pupil to acquire knowledge as a result of his own observations. At first sight, as ideal Nature Study is carried on out of doors in natural surroundings, wonder might be expressed as to what part in such work the museum could play. It has all along been recognised during the Nature Study movement that it is not always possible to be in the field—there are some observations which can be made under a roof which would not be possible or most difficult to carry out in the open—and that the watching of animals in aquaria and vivaria, in observatory bee-hives, and artificial ants' nests may supplement and may even prove a fair substitute for outdoor observations. It is, then, to the living side of the Children's Museum that we must turn in this connection, though, as we shall see, it may be brought in with much effect in regard to other work.

Even preserved specimens may have a value in Nature Study. They may be records of work which has been done; they may illustrate, for instance, the life-histories of insects that have been reared by the pupils in the case of a school museum; or they may be collections made on rambles, illustrating some particular habits of plants or animals. If they have been mounted and described by the scholars themselves in proper museum style it will have given them some training of a kind which is not easily equalled; for not only will they have had to make the original observations, but also to exercise more or less skill in manipulation, neatness, and a considerable amount of good taste, as well as to write a description in a brief and clear manner.

Reverting to our suggestion that changes should be made in the museum where it is small, and bearing in mind that there is very little room available for school collections, as well as that the making of them is an important point in Nature Study, we would suggest that Nature Study records should be continually replaced. The old exhibits can be afterwards passed on to classes to which didactic lessons are given, and, though possibly being put on exhibition in another section of the museum from time to time, may be kept stored away to be brought out when required.

In a public museum preserved specimens may very usefully suggest series of observations that can be made, and if the objects be seasonable the changing of them will be a natural sequence. We shall expect to see methods of seed dispersal shown in the late summer, and fruits opened by birds and beasts for their living, during the late autumn and winter, while there may be other series which will give a hint as to work that can be carried on at any time. Further details may be looked for in a list of suggested series that we shall give later.

Turning now to the didactic side, we shall find that living animals may, equally well with the dead ones, give an idea of forms that can be met with in the neighbourhood and elsewhere, so that some knowledge of classification may be gained.

From the aquaria, minute forms of life can be obtained, and microscopes should be at hand for their examination. Unicellular and filamentous plants can just as easily be studied as Protozoa. Sponges may not be easy things to keep. Hydra, though not typical of the Hydrozoa, may serve to illustrate the group Coelenterata, and there is a colonial freshwater form (*Cordylophora*). Among marine creatures some forms of sea-anemones will thrive well in inland salt-water aquaria, and to the ocean we must go for any representative of the Echinodermata. The common starfish, or five-finger, will often live for a considerable time in captivity. Many representatives of the Vermes—threadworms, rotifers, leeches—live in freshwater, as do Crustacea, and certain insects and water-spiders among the Arthropods. Some of the most beautiful of microscopic animals are the freshwater Polyzoa, and the Mollusca are well represented. Other insects in the caterpillar stage will be reared in breeding cages on their special food plants. Observatory hives and ants' nests have already been specially mentioned. Land Molluscs will occupy vivaria. In aquaria, again, will be the fish, the early stages of the frog; adult amphibians, and the reptiles will need vivaria. Animals higher in the scale are not so convenient to deal with in a museum, but if birds are not to be kept in cages then it may be possible to get some of the wild ones to come to the windows for food, and at the right time of year observatory nesting boxes could be placed inside the children's museum (with the entrance opening to the outside), so that the birds could be watched when building their nests.

In the case of mammals, such tiny forms as the harvest mouse might be shown. It would be advisable to choose, so far as is possible, common British animals, but occasionally, when opportunity offers, some interesting creatures from abroad might be introduced.

It may not be necessary to say anything about the necessity of labelling aquaria, but it is advisable to urge that one kind, or at the outside two or three kinds, of animals, should be kept in a single tank. Sketches of the inmates and of the various weeds growing in the water would help to make matters clear.

The actual receptacles that can advantageously be used will, if possible, be described later, with the methods recommended for exhibiting ordinary museum specimens. It may be said, however, that, whenever possible, glass-topped boxes of uniform dimensions, or multiples of a particular size, should be adopted for the following reasons among others:—

(1) The specimen when once mounted is kept clean and preserved from injury, and is not easily divorced from its label, which also is not allowed to become dirty.

(2) Series can be arranged in orderly sequence and easily displayed.

(3) Fresh boxes can be introduced anywhere with the minimum of difficulty.

(4) The specimens can be conveniently carried about and passed round a class.

In planning out the collections of specimens which are not alive, the question of space will have to be considered, and also the particular object that the museum is expected to fulfil. A classificatory series may be arranged so as to go into very great detail. It may be sufficient to show a few salient points about mammals, for instance, or to illustrate the hair, teeth, skeleton, and structure of the class. In a school where biology is an important subject, all groups might be treated and the part of the collection bearing upon the work of the moment displayed for the time being in the museum. If everything be on view at once the museum can only be looked upon as a storehouse by those who have become familiar with its contents. It is true that one generation of scholars succeeds another, but each individual may remain at school for a number of years.

Collections illustrating habits should specially be mentioned, and series of specimens can be brought together illustrating subjects of general biological interest, such as variation, secondary sexual characters, hybridisation, and protective coloration.

A local museum should usually have for reference specimens of the common species of plants and animals found in the neighbourhood. These should be useful in identifying any doubtful find. It is to be hoped that enthusiasts in schools may have access to such collections, as it will often be beyond the scope of the school museum to have local series. It might, however, be useful if a school were to specialise in certain groups, and not take up everything that comes to hand. Here, again, though the series would usually be out of sight, it might not be amiss occasionally to attract attention to them by exhibiting them.

Very useful work has already been done by museums in preparing object lessons for their juvenile visitors. The work is not intended to take the place of independent nature study observations. They are lessons pure and simple, but made most interesting and valuable by the introduction of concrete examples of the things concerned.

Lastly, we may mention exhibits which are useful in showing what kinds of observations can be made out of doors by those who have the opportunity, and suggest the collecting and mounting of similar series on the part of those who see them.

(*To be continued.*)

THE SCOTTISH ZOÖLOGICAL PARK.

By Dr. WILLIAM S. BRUCE, F.R.S.E.

(Vice-President of the Zoölogical Society of Scotland.)

Several attempts have been made to establish a zoölogical garden or park in Edinburgh, a movement in which Scottish zoölogists have been very keenly interested. None of these was successful, however, until a small body of zoölogists and laymen made a determined effort in 1910 and founded the Zoölogical Society of Scotland. These pioneers each paid an annual subscription and induced a few others to do the same. A practical start was made by the organisation of a few lectures on a small scale, and the exhibition at these lectures of living animals. These lectures and exhibitions were well attended, and every meeting brought more members—all enthusiasts in the cause—into the Society. The Society was then more definitely constituted, and elected a capable executive of business men and zoölogists. These were found especially in the persons of Lord Salvesen, Professor J. Cossar Ewart, Mr. Thomas B. Whitson, and Mr. T. H. Gillespie. A grant of £500 from the surplus of the Scottish National Exhibition (1909) Fund helped to put the young Society into the position of having at its back a small capital, and it was pleasing that a further small sum that had been lying on deposit receipt for forty years, the remnant of the funds of the old Edinburgh Zoölogical Garden, should have been transferred by its trustees to the new Society.

So successful were these early efforts that in the autumn of 1912 there were two hundred and fifty members of the Society, and one of the largest halls in the city had to be taken for the lectures which were now well attended by the general public. In the meantime quite a number of available sites were inspected, and the best expert advice was taken to determine which should be ultimately chosen.

An estate on the well-wooded slopes of Corstorphine Hill was chosen, and an appeal issued for funds for purchase and equipment; £12,500 was quickly raised, and the Town Council of Edinburgh, at the request of the Society, bought the site, consisting of a mansion and seventy-four acres of ground, and feued the property to the Society for the purpose of a zoölogical park.

The work of laying out the Scottish Zoölogical Park was begun in April, 1913.

The site is divided into two portions. The southern portion consists of a mansion house with gardens, shrubberies, and parks surrounding it, and comprising twenty-seven acres: this is the portion at present being developed. The other portion, extending to forty-seven acres, is reserved for future extension, and will provide magnificent ranges for buffaloes, deer, antelope, sheep, and goats. The site is on the southern slope of Corstorphine Hill: it has abundance of growing timber and rock, and has been characterised by experts who have inspected it as one of the finest and most beautiful sites in the world for the purpose of a zoölogical park. When completed the Scottish Zoölogical Park will probably be unsurpassed by any existing zoölogical park or garden.

Gratifying as were the early efforts of the promoters, they have been still more so since the opening of the Park to the public on July 22nd, 1913, for no less than one hundred thousand people visited the Park, and the excess of revenue (excluding Fellows' annual subscriptions) amounted, during three and a half months, to a sum not far short of £1000.

Heavy outlays up to date have been made on roads, fencing, laying of watercourses and drains, construction of water-fowl ponds, dens for polar bears, lions, leopards, and other carnivora; aviaries, monkey-house, bandstand, refreshment rooms, and lavatories. There is an excellent polar-bear den and pool (see Figure 68) in which there are two polar bears and two brown bears. It is blasted out of the whinstone rock, and thus the rock scenery is not artificial, but is actually the natural rock *in situ*. Spacious as is the pool already, it will ultimately be double its present size. Here both polar and brown bears disport themselves, and are seen to great advantage in their actual surroundings with no barrier between them and the visitors except a handrail on the crest of a vertical cliff of rock, up which the animals are not able to climb, rising out of the water. Two similar dens, hewn out of the natural rock, are at present being constructed for the lions and for the leopards: these are nearing completion. These dens are being constructed on the lines of Hagenbeck's dens. The lions' den will be fifty-five feet long, bounded at the back and ends by an overhanging cliff, and in front by a deep trench across which the animals cannot pass. The den is so arranged that it presents a succession of excellent views to visitors as they ascend the walks.

So far three ponds have been constructed for water-fowl (see Figures 70, 72 and 73), and these and the bear pool form at present leading features of the enclosures. Each pond has its own attractions, and along with the bear pool give an idea of what the Council of the Scottish Society are aiming at, namely, to have animals exhibited in comfortable quarters as nearly as possible resembling their native habitat.

One of the first enclosures one meets with on entering the Park is that of the bison. It is a large paddock, surrounded by a low fence of fir poles, with an inner ditch which prevents the bison from charging the fence. Near it is the foreign water-bird pond, and rising up the hill one comes to other

FIGURE 67. Polar Bears drinking and swimming.

FIGURE 68. Polar Bears and Brown Bears [illegible]

FIGURE 69. Terns.

FIGURE 70. The Crane Pond.

FIGURE 71. The Hyena.

FIGURE 72. The King Penguins.

FIGURE 73. View showing one of the Bird Ponds.

FIGURE 74. The Llama in snowy weather.

pools and ponds, mostly alongside the main winding pathway. All these pools are supplied from natural springs, and the existence of these was all along to be one of the leading features of any ground the Society meant to acquire in order to save a heavy water bill. These springs are not likely to fail, as the Society's Park extends beyond the summit of the crest.

One of the difficulties has been to induce people to believe that animals such as lions could exist in Edinburgh during the winter, a fallacy it was very hard to kill, in spite of much expert evidence to the contrary. As a matter of fact, the climate of Edinburgh is a very equable one, having neither the extreme heat nor cold of either Hamburg or New York, where excellent zoölogical gardens exist.

During the New Year holidays there has been a good trial, because there has been an exceptionally cold spell, with rather rapid changes. Snow has fallen quite considerably, and then quite sharp frost for this part of the world has followed, and none of the animals appear to have suffered in any way. The animals, provided with dry and sheltered sleeping-accommodation, appear to be amenable to the outdoor life to which they have been subjected. The monkey-house, part of which has been built, is, for instance, an entirely out-of-door structure, as is also the large parrot aviary, and the lions and other large carnivora also live almost entirely in the open.

The Society aims at having a representative series of animals, and already the collection—partly purchased, partly loaned, and to a large extent generously given—is well worth visiting.

The Dublin Society has gifted a fine pair of lions, while Lord Pentland, till lately Secretary for Scotland, has secured an elephant, through the generosity of the Maharajah of Mysore; and, last, but not least, a most interesting series of Antarctic animals has arrived, having been presented to the Society by Messrs. Salvesen, of Leith. This series includes two young sea-elephant seals, a young Weddell seal, and six penguins of three species. Southern Sea elephants (*Macrorhinus elephantinus*) have never been seen alive north of the Equator, and it will be very interesting to watch the development of this pair of healthy animals that have been transported seven thousand miles to their new home. The habitat of the sea elephant is in sub-Antarctic seas, both Atlantic and Pacific, south of the latitude of 40° S. The Weddell seal (*Leptonychotes weddelli*) is even more interesting than the sea elephants, because it is a true Antarctic species, and has certainly never been exhibited in any zoölogical garden in the world; moreover, the type specimen is housed in the Royal Scottish Museum, and has been described by Professor Jamieson, of the University of Edinburgh. The Weddell seal is a typical shore seal of the Antarctic regions, being found in shallow water off the coasts. The penguins are also interesting: four of them are king penguins (*Aptenodytes pennanti*), which have been exhibited before in the Zoölogical Gardens of London, as well as in other places; but it is probably quite a new feature to have two of these interesting birds in the down stage. The second species of penguins secured is the gentoo penguin (*Pygoscelis papua*), which has been rarely seen in European zoölogical gardens, although recently there has been one in the Zoölogical Garden of London. The third, the macaroni penguin (*Catarrhactes chrysolophus*), with its beautiful golden crest, possibly constitutes another European and American record in being exhibited in a zoölogical garden. Like the seals, these penguins have taken very kindly to their new home. They were all taken in the interesting island of South Georgia, which has recently become a great centre of the whaling industry, and they form an interesting and important contribution to the collections of the Zoölogical Society of Scotland.

THE ZOÖLOGICAL SOCIETY OF LONDON.

At the meeting of the Zoölogical Society held on February 17th, Mr. E. G. Boulenger, F.Z.S., Curator of Reptiles, exhibited a photograph of a female example of the Giant Saddle-backed Tortoise (*Testudo abingdonii*) recently purchased by the Society. On the arrival of the tortoise, the origin of which was unknown, Mr. Boulenger was somewhat puzzled as to the species to which it should be referred, but, on carefully comparing it with the Saddle-backed Tortoise in the British Museum, came to the conclusion that the specimen was none other than the hitherto-unknown female of *T. abingdonii*, a species which had never previously been brought to Europe alive, and which was thought to be extinct. An inspection of the very representative collection of Giant Tortoises in the Tring Museum strengthened the conclusion arrived at.

From the few male specimens in museums, this Tortoise differs by the fore-part of the shell being less strongly compressed and not reaching the same height, more as in *T. ephipium*, by the comparatively greater breadth of the hinder part of the carapace, by the broader bridge, and by the smaller size of the marginals bordering the bridge

Mr. Boulenger also remarked upon some of the habits of this species. Among the papers read was one by Professor F. Wood-Jones, on some phases in the reproductive history of the female Mole (*Talpa europea*). He dealt with the nature-lore connected with the sexual evolution of the Mole, the embryological development of the reproductive system, seasonal changes in the external sexual characters of the adult female, and the character of these changes as seen in microscopical sections of embryos, nestlings, and adults.

METEORIC ASTRONOMY.

By W. F. DENNING, F.R.A.S.

During the last few years meteoric astronomy has been spoken of in rather flippant terms by certain individuals. I do not think that any astronomer of high standing has disparaged this branch, but there are certain others who apparently fail to discern its importance, who are sceptical in regard to its theories, and who question the accuracy of the observations.

But, in spite of opposition, the department of astronomy dealing with meteors will continue to hold an important position because its teachings are widespread and significant. The structure raised by Coulvier-Gravier, Heis, Schmidt, Lowe, Schiaparelli, H. A. Newton, A. S. Herschel, and others will stand and flourish amid the increasing knowledge of succeeding ages.

In the few past years there has been unusual activity apparent in several lines of astronomical research; a number of large volumes have been published containing an immense amount of observational data concerning variable stars. Very little has been printed about meteors save a few small pamphlets or papers in scientific journals. Yet meteors are the connecting links between our Earth and other worlds. Millions of them are consumed in our atmosphere every day, and they are the only celestial bodies which we may view from a near standpoint, and submit to microscopical analyses.

They are also sometimes the most beautiful objects which the heavens present. To witness, on a clear starlight night, the slow, majestic flight of a fireball across the firmament affords a spectacle of unique grandeur. A richly coloured sunset supplies a magnificent scene; the sight of a new star, such as Nova Persei in February, 1901, is deeply impressive from its mystery, and the immense conflagration of which it is the distant emblem; but these things lack the transient glories of the meteoric fireball, which can bring day amidst the darkest night, and have been known to outshine the dazzling lustre of the Sun.

Misapprehensions, sometimes the outcome of a lack of knowledge, have caused certain people to neglect the study of meteors. The photographic method is thought to be the only accurate way of recording meteor paths, or of correctly fixing meteoric radiants. This is a great mistake. If a radiant were a point formed by the perfectly symmetrical convergence of meteors, then photo-trails, if they could be got, might indicate its place to the hundredth part of a degree. But a radiant is sometimes an area of several degrees; the Andromedid shower of November 27th, 1885, had a radiant spread certainly over more than seven degrees, and probably over more than ten degrees. Now, if one hundred meteors were photographed, and one hundred recorded by a good observer, the degree of accuracy would not be greatly in favour of the former, because certain parts of the area must give undue radiation at various times, and there might be a preponderance from one side just when the photograph was taken. Again, there are meteors which may cross one radiant and belong to another; and the exact place of a radiant varies from hour to hour owing to zenithal attraction and to other causes. Every meteor path, in fact, ought to have corrections applied to it.

For a single meteor, the photo-plate supplies a splendid record. Even the little variations of light along the path are distinctly shown, and I must say that it affords great satisfaction to work on the basis of such a record. But a good naked-eye observation need not be more than half a degree out in the direction at the assumed beginning and end points of a meteor, and the radiant point of a well-observed shower may often be derived within one degree.

When we consider the *area* of radiants, and the fact that the wrong meteors are sometimes applied to showers, we can easily see that a radiant determined by photography may be little more reliable than one formed by naked-eye estimates, and for the moment I am giving undue powers to the camera, for it has been found ineffective to gather a sufficient number of trails for fixing radiant points. Bright meteors are the only ones impressed on the plates, and for general purposes of meteoric record the photographic method has been a failure. While a man is occupied in getting a good meteoric photograph he could probably secure the observation of one thousand by the unaided eye.

I am convinced that the errors usually applied to meteoric observation are immensely overrated when applied to the case of an experienced and really capable man. If we regard many newspaper reports of meteors and records by casual observers as fair criteria, then the observations are wild indeed and deserve to be disregarded. Even by observers otherwise skilled in astronomical work a meteor's flight is sometimes terribly perverted, and makes confusion worse confounded when the computer endeavours properly to reduce the observations.

When, however, two good observers witness a meteor, and calmly record the essential features of its display, the height at appearance and disappearance can be worked out with a probable

error limited to two or three miles, and the radiant-point assigned to within two degrees and sometimes less.

If a man be peculiarly fitted by certain natural talents for the observation of meteors, it is astonishing to what accuracy he can attain after considerable practice. Having examined the results of many observers and made comparisons, I can confidently assert that the estimated eye observations are often very exact and trustworthy. We may turn to other departments where eye estimates have to be relied upon, and are even more correct. The magnitudes of variable stars are often thus recorded, with a little help from binoculars or ordinary telescopes; and transit times of spots on the telescopic disc of Jupiter are quite as well made by the eye as by micrometric measurement. There is no reason why the eye registration of meteor flights should not be made accurate in a degree scarcely thought practicable. They can never, of course, be made so beautifully true to nature as the photographic picture, but they can be obtained correctly to within an almost inappreciable extent in the line representing their *direction*, and this is really the important feature for ascertaining the radiants. For finding the lengths of paths and deducing the heights of beginning and ending we require great accuracy in other features as well as the *directions*. For myself I have always endeavoured to get the latter element as correctly as possible, for without it it is impossible to find reliable centres of radiation.

Nearly fifty years ago the observations of certain showers, such as the Leonids and Perseids, had been made with sufficient accuracy to prove that they radiated from the same points as periodical comets, and the great showers of 1866, 1867, 1868, and 1872 served to attract general attention to the subject of meteors; but since 1885 the lack of great displays and the want of any new cometary associations have served to bring about a decline of interest. Many things happened in the period between 1866-1872 to boom meteoric astronomy, and our knowledge exhibited rapid developments. Its progress has naturally been slower since, though many useful facts have been accumulating. We may look forward to another active period in this branch when past observations will be properly assembled and assorted. Our theories may require some little amendment, but the practical identity of comets and meteors will stand the test of further investigation.

The claims of meteoric astronomy need no enforcing from me. The names of the astronomers previously given who have been actively engaged in its study are sufficient to impress anyone both with the attractiveness and the importance of this branch. In this paper I have simply endeavoured to point out a few facts which seem to be scarcely sufficiently recognised.

NAPIER TERCENTENARY CELEBRATION, JULY, 1914.

John Napier's "Logarithmorum Canonis Mirifici Descriptio" was published in 1614; and it is proposed to celebrate the tercentenary of this great event in the history of mathematics by a Congress, to be held in Edinburgh on Friday, July 24th, 1914, and following days.

The President and Council of the Royal Society of Edinburgh have now the honour of giving a general invitation to mathematicians and others interested in this coming celebration.

The celebration will be opened on the Friday with an inaugural address by Lord of Appeal Sir J. Fletcher Moulton, F.R.S., LL.D. (Edin.), and so on, followed by a reception given by the Right Honourable the Lord Provost, Magistrates and Council of the City of Edinburgh. On the Saturday and Monday the historical and present practice of computation and other developments closely connected with Napier's discoveries and inventions will be discussed.

Merchiston Castle, the residence of Napier, has long been occupied by the well-known public school, which draws pupils from all parts of the British Empire. The Governors of the school have kindly invited the members of the Congress to visit the Castle and grounds on the Saturday afternoon.

Relics of Napier, collected by Lord Napier and Ettrick and other representatives of the family, will also be on view; and it is intended to bring together for exhibition books of tables and forms of calculating machines, which are natural developments of the great advance made by Napier.

Individuals, Societies, Universities, Public Libraries, and so on, may become founder members on payment of a minimum subscription of £2; and each founder member will receive a copy of the Memorial Volume, which will contain addresses and papers read before the Congress, and other material of historic and scientific value. It is important to secure as many founder members as possible, so that a volume may be brought out worthy of the memory of Napier.

Subscriptions and donations should be sent to the Honorary Treasurer, Mr. Adam Tait, Royal Bank of Scotland, St. Andrew Square, Edinburgh.

All who are interested in this proposed celebration are respectfully invited to communicate with the General Secretary of the Royal Society of Edinburgh, 22, George Street, Edinburgh, and to announce their intention of being present.

SPORE DISPERSAL IN THE LARGER FUNGI.

By SOMERVILLE HASTINGS, M.S., F.R.C.S.

(*With illustrations from photographs by the writer.*)

THE fungi are probably the most prolific of all living organisms. An average-sized mushroom will produce as many as eighteen hundred million spores, and a common toadstool Shaggy Caps (*Coprinus comatus*), which grows in fields and on rubbish, has been shown to produce as many as five thousand millions. Fortunately for the other inhabitants of the world, however, the probability of germination and successful growth of any given spore is somewhat remote. The mushroom or toadstool plant is formed by fine filamentous threads which ramify beneath the soil; and, if we assume that a successful plant of the mushroom or Shaggy Caps produces as many as ten mushrooms or toadstools, we find that the chance against successful germination and growth to maturity of any given spore is respectively about eighteen thousand millions and fifty thousand millions to one in the two species mentioned. But even more prolific than the mushrooms and toadstools proper is the Giant Puffball (*Calvatia gigantea*) (see Figure 75), a large specimen of which has been known to produce as many as seven million million spores. Shaggy Caps—the toadstool just mentioned—rarely takes more than about twenty-four to forty-eight hours to shed its spores, and at the end of this time has dissolved into an inky mass. The mushroom also rarely resists decay more than a few days, but there are woody fungi which persist for years, and some of them go on shedding their spores for a very considerable period. *Polyporus squamosus* (see Figure 76), which produces shelf-like fruit bodies from the trunks of trees, has been observed to shed its spores continuously for as long as thirteen days. It has been calculated that as many as a hundred thousand million spores will be thus produced from a single fruit body of this fungus in one year. I myself have watched the spores falling from another very common toadstool, *Polystictus versicolor* (see Figure 78), at intervals for three days, and personal observation of the continual stream of spores given off by any of these fungi will give one a more readily appreciated idea of the vast quantity produced than any number of figures.

No more interesting demonstration can be imagined than that of the fall of spores from a fungus by the beam of light method. For this purpose any ordinary toadstool may be used, but many of the woody forms have this great advantage, that they can be kept dry for months or years, and yet, when moistened by water being poured on their upper surface, they swell out, and in a few hours begin to produce spores again. Specimens of *Lenzites betulina* or of *Polystictus versicolor* (see Figure 78), the commonest of our woody forms, are specially useful for this purpose. The toadstool is nailed, gills or pores downwards, on to a piece of wood. This forms the cover of a large beaker—the larger the better. A room which can be darkened, a long extension lantern and a lens of three or four inches in diameter, are also required. A lantern with an ordinary incandescent gas or electric lamp does fairly well, but limelight or a small hand-fed arc lamp is, of course, better. Where the lantern has not a long extension the front lens can be carried forward by a short cardboard tube. In this way a nearly parallel beam of light is produced, which is concentrated still further by means of the lens mentioned above. The beaker, placed close to the lens, is raised or lowered till the beam of light passes immediately below the fruit body of the fungus. With a white-spored toadstool something like a miniature snowstorm now appears from the fall of a million spores a minute if the toadstool is a large one; and the warmth of the beam of light or of the observer's body, conducted through the glass of the beaker, produces cross-currents and eddies which seem to turn the snowstorm into a regular blizzard. The demonstration can be made even more striking if the cover of the beaker with the fungus attached be occasionally removed, and the interior temporarily cleared of spores by blowing into it from the mouth. When the cover and attached fungus are again replaced the commencement of spore-fall is especially striking.

When we consider the large number of spores produced by most members of the fungus tribe, it is a little surprising that any special devices for their distribution have been developed. We might have supposed that if left alone a sufficient proportion of them would be sure to find a suitable location for germination and growth. But it is important to the parent plant to have its progeny as far removed from it as possible, and therefore various methods of spore dispersal have been evolved. Indeed the whole structure of the greater number of the larger fungi will show how excellently they are adapted for the distribution of their spores. It is curious to note how closely the methods of spore dispersal in the larger fungi resemble those of seed dispersal in the higher plants. Arrangements for spore dispersal by the agency of animals, insects, and the wind are all seen, and a few fungi

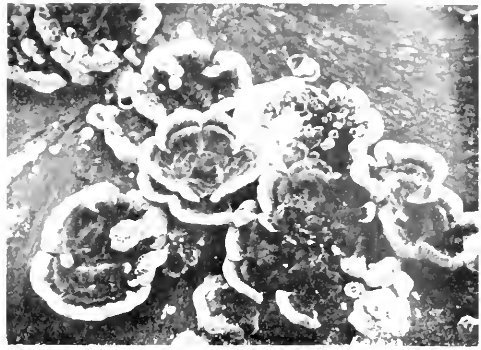


FIGURE 81. *Helvella lacunosa.* A form in which "pitting" may be observed.

FIGURE 82. *Stropharia squamosa.* A form with a long stalk which raises the cap well above the ground.

FIGURE 83. The Common Morel, *Morchella esculenta.*

FIGURE 84. *Mitrula viride.* An Ascomycete with a club-like form.

FIGURE 85. *Morchella conica.* A pretty little Morel appearing in summer.

FIGURE 86. *Peziza badia.* A cup-shaped Ascomycete.

FIGURE 87. *Bulgaria inquinans.* An Ascomycete with [illegible] surface which is nearly flat. It grows on trees.

FIGURE 88. *Sepultaria coronaria.* A fungus which comes up in spring. Its inner spore-bearing surface is protected in the early stages of its development.

shoot their spores to long distances in the same way that the Broom and other plants shoot out their seeds. It will thus be seen that very similar methods of seed and spore dispersal are found in both fungi and flowering plants, but there is this difference, that the spores of fungi are so much lighter than most of the seeds of flowering plants that a larger proportion—indeed, many of the most highly developed members of the class—make use of the wind for the distribution of their spores, and practically the whole of the toadstools proper—that is, fungi with an umbrella-like form—have their spores distributed in this way.

If we take a mature mushroom or toadstool of any sort, and, breaking off its stalk, lay it, pores or gills downward, on a piece of paper beneath a cover for, say, twelve or twenty-four hours, and then carefully remove it, a more or less perfect map of the lower surface of the cap will be seen. This toadstool *autograph*, as it may be called, is produced by falling spores, and is easily seen in the dark-spored varieties. But where the spores are pink or white it may not be noticed if ordinary white paper be used; it is therefore preferable to use a piece of printed paper instead.* In nature it is unusual to find any visible mass of spores on the ground beneath toadstools growing singly or in small groups. Where toadstools form large masses, the spores from the higher are sometimes found deposited on the caps of the lower as well as all around them. On ground surrounding a large clump of the Stump Tuft (*Armillaria mellea*) (see Figure 77), for instance, an appearance almost like that of mildew may sometimes be seen produced by myriads of small white spores; so thickly are the spores deposited indeed that one cannot help doubting whether such large clumps of toadstools are as efficient for purposes of spore dispersal as a number of small tufts.

Although a vast number of spores are produced by most fungi, a sufficient number to be visible to the unaided eye is the exception rather than the rule, and the two main factors which are responsible for this are the very constant presence in the larger fungi of a sterile stalk (see Figure 82), which raises the spore-producing area an appreciable distance above the level of the ground, and the existence of air currents close to the ground. It has been shown that in perfectly still air spores take an appreciable time to fall from the gills to the ground. This varies from twenty-five seconds in the case of the relatively heavy spores of the *Amanitopsis vaginata* to one hundred seconds with the light spores of *Collybia dryophila*. Where the fungi grow out from trees (see Figure 79), or form shelf-like projections (see Figure 76), the spores, of course, take much longer to reach the ground. Owing to the warming of the ground by day and its cooling by night, to the drying up of moisture and other causes, it is probable that even on the stillest of days, when there is no apparent breeze at all, the air immediately above the surface of the ground is never quite still, and that even in fields and woods there is an air current of at least one or two feet per minute. Falck found that when a mass of spore-bearing tubes from a fresh specimen of *Polyporus squamosus* were pressed together, and enclosed in a specially insulated chamber for several hours, their temperature was 9·6 C. higher than that of similar tubes which had been killed by heat, and suggests that air currents produced by the higher temperature of a fungus may be of value to the plant in the dispersal of its spores. I have myself observed a raised temperature compared with that of the external air, sufficient to be detected by the hand, in the interior of a rapidly developing specimen of the Giant Puffball (*Calvatia gigantea*) (see Figure 75); but whether there is any rise of temperature on the surface of fungi of the mushroom type has yet to be demonstrated. Falck also suggests that certain toadstools have developed thickened caps and stems, on which maggots feed, so that these creatures may produce sufficient heat to form convection currents and help in the distribution of spores. It is probable, however, that maggots do more harm than good to most fungi by weakening the stalk and interfering with the exactly vertical position of the gills; and that, except perhaps where a fungus is much enclosed by dead leaves or surrounding objects, the heat produced by the plant itself or by contained maggots is of very little importance in spore dispersal.

The larger fungi, bearing spores produced on their outer surface, which are dispersed by the wind, can be divided into two main classes, the "Long-shooters," or Ascomycetes, and the "Short-shooters," or Hymenomycetes (Basidiomycetes). In both forms the spores are forcibly shot off from the cells that bear them; but whereas in the Short-shooters the spores never travel for more than a small fraction of a millimetre before all momentum is lost, and gravity alone affects them, in the Long-shooters the spores are shot out forcibly a distance of one to several centimetres. In both kinds the spores are very adhesive, and stick to anything they touch. If a toadstool, for example, which is rapidly shedding spores, as seen by the beam of light method, be turned gills upward and left several hours, and then again inverted and examined by a beam of light, no sudden rush of falling spores will be noticed, but spore discharge will begin and continue at exactly the same rate. Bearing in mind, then, the sticky nature of the spore, it

*An interesting permanent preparation can be made by taking an ordinary undeveloped lantern slide or photographic plate. All the silver is dissolved out in "hypo," and the plate washed and excess of water drained off. It is then laid, film upward, on a flat surface and the toadstool placed, gills downward, upon it.

will be seen that in both forms it is necessary to have the spore-bearing surfaces at such a distance from other free surfaces that the spores when shot out do not strike and adhere to the latter. In the higher members of both forms an increase in the area of the spore-bearing surface has been accomplished by folding, which has resulted in gills, tubes, and so on. There is this difference, however, that whereas in the Long-shooters the folds have to be relatively far—in most cases at least a centimetre—apart, in the Short-shooters they can come within a fraction of a millimetre of one another if there be a space below down which the spores can fall. The result of this has been that the Short-shooters have been able to develop a relatively much larger area of spore-bearing surface, and perhaps largely for this reason, both in number and variety of species, Short-shooter toadstools, with gills and tubes, have become the most successful of the larger fungi.

In nearly all the Short-shooters (Hymenomycetes) the spores are borne in groups of four on outgrowths from the free extremity of elongated cells—the basidia. The spores are shed one after the other at intervals of a few seconds or minutes. A double-cell wall seems to develop between the basidium and the spore, and by increase of tension in the basidium or spore, or both, a strain is set up, and separation between these two suddenly occurs, and the spore is jerked off without rupture or injury to the basidium. The Long-shooters (Ascomycetes) have a number of much elongated cells (asci) packed closely together. In each ascus, near its free extremity, are eight spores arranged one above the other. Spore dispersal takes place by rupture of the ascus at its tip. Then the eight spores, with a certain amount of cell sap, are suddenly shot out, and in some forms at once become separated from one another.

Spore dispersal in the larger Ascomycetes may sometimes be observed without the aid of the beam of light method. I had laid the specimen of *Helvella lacunosa* shown in Figure 81 on a sheet of glass in an empty room, intending to photograph it, but was called away. When I returned several hours later I happened to touch the glass with my hand, when the upper part of the fungus, for a distance of about two inches around, became immediately surrounded by a sort of halo, which was easily seen in ordinary daylight, and remained in position for several seconds. On tapping the glass again nothing further happened, but I was able to repeat the observation and demonstrate it to another about an hour later. This " puffing " or sudden discharge of spores has been noted in many other species of the Ascomycetes. Probably the sudden shock is sufficient to determine the rupture of a number of asci which are ready to discharge their spores, and " puffing " results.

In *Helvella* the spore-bearing surface is irregularly folded, or saddle-shaped, and raised above surrounding objects by a stalk. *Helvella crispa* (see Figure 80) is the most common species. Where the folds are deeper, so that we have the appearance of a sponge with a stalk (see Figure 83), a Morel (*Morchella*) results. But even here the folds are coarse, as already explained. In *Mitrula* (see Figure 84) the spore-bearing tissue covers the upper part of a small club, and in *Bulgaria* (see Figure 87), which grows on fallen trees, the spore-bearing surface is nearly flat. *Peziza* (see Figure 86) is a cup-shaped fungus, with the spore-bearing tissue on the inside of the cup. The spores are shot outside the cup, and are then carried away by the breeze. As will be seen by Figure 88, the cup-shaped form is of advantage to the plant by protecting the sporogenous tissue from injury during the early stages of development. In the Candle-snuff fungus (*Xylaria hypoxylon*) (see Figure 90) there are two sorts of spores: dark ascospores are borne on the lower part of the stem, and white conidia form a powdery mass around the top. Besides the above many other forms of Ascomycete are, of course, met with.

Turning now to the Short-shooters (Hymenomycetes) we find, among the less highly organised members, certain genera very closely resembling the Ascomycetes in external form. Thus *Clavaria* (Figures 89 and 94) corresponds fairly well with *Mitrula*, and *Sparassis* (see Figure 91) closely resembles *Morchella*, except that it has no stalk. Corresponding to *Bulgaria*, with a more or less plane spore-bearing surface, we have *Stereum* (see Figure 92). *Stereum* forms flat plaques placed vertically on the bark of trees and shrubs, or forms shelf-like projections, the spore-bearing surface being underneath. Sometimes, particularly when growing on fallen logs, the spore-bearing surface is uppermost, a much less effective position in the absence of wind than in the corresponding genus *Bulgaria*. Since the spores are shot out such a short distance they are almost sure to fall back and adhere to the parent plant. Somewhat resembling *Peziza* is *Craterellus* (see Figure 93), shaped like a horn of plenty, but there is this difference, that here the spore-bearing tissue is outside. Nor is it likely that many of the adherent spores of a Short-shooter would be carried far beyond the plant were they developed on the inside of a hollow cone, with its apex downward.

(*To be continued.*)

FIGURE 89. *Clavaria pistillaris.* A Hymenomycete of a club-like form.

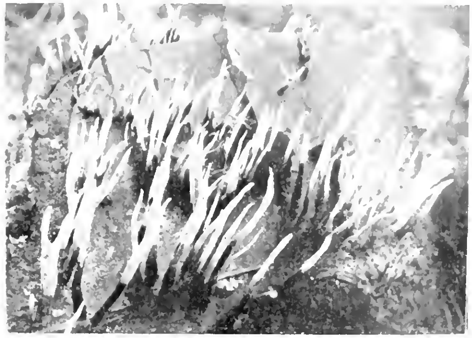


FIGURE 90. The Candle-snuff Fungus (*Xylaria hypoxylon*) which bears two sorts of spores.

FIGURE 91. *Sparassis crispa.* A Hymenomycete resembling a large sponge.

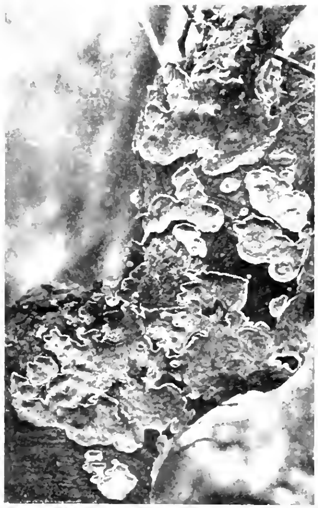


FIGURE 92. *Stereum rugosum,* which forms flat plaques on the trunks of trees.

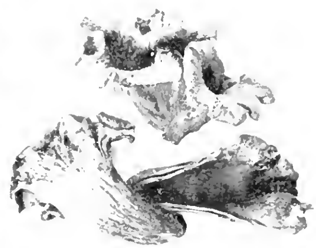


FIGURE 93. *Craterellus cornucopioides.* A cone-shaped Basidiomycete bearing its spores on its outer surface.

FIGURE 94. *Clavaria cinerea.* A branched club-shaped species.

FIGURE 95. *Hydnum* [illegible] A [illegible] instead of [illegible]

FIGURE 96. The Ringlet.

FIGURE 97. The Brimstone.

FIGURE 98. The Purple Emperor ♀.

From Photographs by Douglas English.

[From "Wild Life," Vol. II. Edited by Douglas English. By the courtesy of the Wild Life Publishing Company.]

REVIEWS.

BIOLOGY.

The Twenty-Seventh Annual Report of the Liverpool Marine Biological Committee.—By W. A. HERDMAN, B.Sc., F.R.S. 70 pages. 24 illustrations. $8\frac{1}{4}$-in. × $5\frac{1}{2}$-in.

(Williams & Norgate. Price 1/6.)

As usual, this report contains a record of the work done at Port Erin Biological Station. Very interesting notes are given on the rearing of young lobsters, and also with regard to the minute life of the sea beach. The illustrations, particularly those of living animals, add greatly to what is quite the opposite of the usual dry and unattractive report.

W. M. W.

Wild Life (Volume II).—Edited by DOUGLAS ENGLISH. 388 pages. 56 plates. 314 figures. 12-in × $9\frac{1}{2}$-in.

(The Wild Life Publishing Co. Price 25/- net.)

However useful the laboratory and the museum, however desirable a knowledge of anatomy or a training in physiology may be, there is no doubt but that it is before the field naturalist that many problems will come for solution. Moreover, the results of outdoor observations will ever continue to be a very great source of pleasure to the majority. The second volume of *Wild Life*, though it contains but four parts of the magazine, will serve to emphasise the infinite variety of the work that can be done. Its pages are only words from the daily history of the bird, butterfly, or the spider, which forms the subject of the articles written by those who know and are willing to share what they have learned with others, who maybe have not the same opportunities or turn their attention to some other creatures. It is not our intention to try and describe in detail what is a tribute to the right feeling of the times, a monument of industry and a mine of information. It is sufficient to call the attention of nature-lovers to such pictures as that of the male avocet trying to persuade the female to leave the nest, the golden eagle and her young, the web of *Epeira marmorea* covered with dew, and the purple emperor on the oak twig (see Figures 96 and 98.)

W. M. W.

CHEMISTRY.

The Progress of Scientific Chemistry in our own Times.—By SIR WILLIAM A. TILDEN, F.R.S. Second edition. 8-in. × $5\frac{1}{2}$-in. 366 pages.

(Longmans, Green & Co. Price 7/6 net.)

The evolution of the science of Chemistry during the past century is a fascinating story, and it loses nothing of its interest as told by Sir William Tilden. Originally the subject matter of the book was embodied in a series of lectures illustrating the progress of Chemistry in the reign of Queen Victoria, but in book form it has been expanded into something much more comprehensive and useful to the student of the science.

In this new edition the work has been brought up to date, so as to include the most recent conceptions upon such subjects as valency, stereo-chemistry, and radio-activity. The arrangement of the book into separate sections, more or less chronologically complete, is retained, and each chapter gains much in interest and value by the addition of the short biographical sketches of the different chemists who have contributed to the progress of their particular branches of chemical science. As the author rightly points out, the student of to-day may learn much from a careful study of the difficulties surmounted by the chemists of yesterday.

The evidence for and against particular theories is fairly given, and it is suggested (page 137) that in such a position of conflicting views as are held, for example, upon the structure of the atom "it is the duty and the best interest of the chemist to preserve a perfectly unbiased mind, and to pursue the safe path of experimental enquiry." This is quite compatible with the conclusion that, although atoms in the more generally accepted sense are capable of disintegrating under stress of electrical forces, they yet preserve their independence under the conditions of ordinary chemical changes.

The book is one that will interest, not only the chemist, but also the general reader. It is printed in type that is pleasant to read, and has a good index and full references to the authorities cited.

C. A. M.

DRESS.

Dame Fashion, 1786–1912.—By JULIUS M. PRICE. 180 pages. 155 coloured plates. $10\frac{1}{4}$-in. × $7\frac{1}{2}$-in.)

(Sampson Low, Marston & Co. Price 63/- net.)

In his preface the author criticises the works on costume published in England, because, though their number is legion, they "all, without exception, treat the subject from its picturesque aspect only." The present reviewer some years ago did attempt to consider clothes from an evolutionary point of view, and when taking up "Dame Fashion" he did so with the hope that he might find something with regard to the origin of particular features in dress or the causes of fashion. It is true that the author sees in clothes a reflection of history, and he has certainly given in his account of the period which lies between the years 1786 and 1912 a very remarkable and fascinating story. With regard to the illustrations it may be said all the coloured figures are taken from fashion-plates. This may insure accuracy as regards details, but, judging from the costumes as we see them in the streets or the ballroom, we should say that fashion-plates do not give an entirely truthful idea of the looks of the people at any particular time. From a developmental point of view men's dress is more interesting than that of women, but only the latter has been considered to be worth illustrating in the present case.

W. M. W.

ECOLOGY.

The Journal of Ecology, Volume 1, No. 4.—Edited by FRANK CAVERS. 250–314 pages. 27–41 figures. 14–28 plates. 10-in. × $7\frac{1}{4}$-in.

(The Cambridge University Press. Price 5/- net.)

This part contains an important article by Professor F. W. Oliver and Mr. E. J. Salisbury on "Vegetation on Mobile Ground as illustrated by *Suaeda fruticosa* on Shingle." The article forms the eighth publication based on observations made at Blakeney Point, which the National Trust has taken over through the efforts of the Society for the Promotion of Nature Reserves. It is shown in the article that if the plant considered, is established it will, as the beach slowly travels over it, respond by continually growing to the surface. By its great capacity for rejuvenescence and power of arresting the travel of shingle, thus raising the height of a beach, *Suaeda* would appear to be pre-eminently adapted for planting on shingle spits and similar formations where the object is to stop the landward travel. Another article forming Blakeney Point Publication No. 9, by William Rowan, deals with the food plants of rabbits. One of the great features of this journal is the reviews and notes on all matters concerned with ecology all over the world.

W. M. W.

EDUCATION.

The Montessori Principles and Practice.—By E. P. CULVERWELL, M.A., Fellow and Senior Tutor, Trinity College, Dublin, Professor of Education, University of Dublin. 309 pages. 19 illustrations. $7\frac{1}{2}$-in. × $4\frac{3}{4}$-in.

(G. Bell & Sons. Price 3/6 net.)

A work on this subject—the last word in the world of education—is very welcome from so able a writer as Professor Culverwell, and his book is a valuable addition to Montessori literature.

It is written in a most interesting manner, expounding the scientific principles which underlie Madame Montessori's methods. The chapters on Spontaneity and Liberty are particularly good, and the whole subject is

treated with insight and understanding. Unfortunately, it is decidedly easier to get hold of Montessori apparatus than Montessori principles, but a careful study of Professor Culverwell's book would insure that the former would not be used without some considerable knowledge of the latter.

A. A.

FUNGI.

Toadstools and Mushrooms of the Countryside.—By Edward Step, F.L.S. 143 pages. 135 illustrations. $6\frac{1}{4}$-in. × $4\frac{1}{4}$-in.

(Hutchinson & Co. Price 5/- net.)

Mr. Step has done a great deal to popularise botany in this country, and his delightful photographs are well known. This little book is one of a series called "Popular Pocket Nature Books," provided with rounded corners, so that they may be taken into the field. The main object, of course, is to enable nature-lovers to identify the toadstools that they come across. The photographic reproductions and the clear descriptions go a very long way to encompassing this, and we feel sure that Mr. Step's "Toadstools and Mushrooms of the Countryside" will be welcomed by all those who want a good deal of information in a compact form.

W. M. W.

NATURAL HISTORY.

Cassell's Natural History.—By F. Martin Duncan, F.R.P.S. 432 pages. 16 coloured plates. Over 200 illustrations. $9\frac{1}{2}$-in. × 6-in.

(Cassell & Co. Price 9/- net.)

An excellent feature of this volume, and one in which it differs widely from a number of its rivals, is the relatively large amount of space accorded to invertebrates, this portion of the work being nearly equal to that assigned to vertebrates. A second feature, which ought to appeal strongly to the public, is the beauty and excellence of the illustrations, especially of the sixteen coloured plates. The one fault in connection with the latter is the absence, in certain instances, as in the group of shells facing page 101 and of tropical butterflies opposite page 146, of any clue to the species depicted. In the case of the shells it might, indeed, puzzle the tyro to decide which are bivalves and which univalves, as the latter shells might easily be mistaken for one valve of a bivalve. Seeing that in other plates the individual figures are properly numbered and named, it is difficult to understand the reason for the omission in the plates mentioned. A lack of reference in the text to the photographic plates is also noticeable, and in consequence of this, for example, the reader has no clue by which to identify the young Somali hyaenas represented in the plate facing page 377 with the spotted hyaena referred to on page 380.

As the author states, the book is written, in the main, in simple and non-technical language, although the statement on page 105, that "*Crepidula* is a protandric hermaphrodite," is calculated to terrify a beginner, despite the fact that it is followed by a partial explanation. Misprints seem few and far between, although on page 138 we note *Paripatus* for *Peripatus*, and on page 377 *Nycterentes* for *Nyctereutes*.

So far as the sections devoted to the invertebrates are concerned, the work appears to be in the main excellent, and the information given trustworthy and up to date. The author, in fact, knows his subject. We wish the same could be said for the vertebrate portion, more especially the mammalian section. In parts of this—notably the chapter on Ungulates—the text can only be described as disgraceful. What, for instance, is to be thought of an author who tells his readers (page 350) that there are three species of zebra—the true zebra, Burchell's zebra, and the quagga—and who figures (plate facing page 348) the second of these as the first? Has he never heard of the Somali Grévy's zebra? Again, it is a bit behind the time to quote the late Sir W. H. Flower to the effect that the only approximation to true wild horses at the present day are the tarpan of the Russian steppes, the author being apparently unaware that these are extinct, and seeming to be quite unacquainted with the existence of real wild horses in the Gobi. These are only a few instances among many that might be cited, and the truth is that no man can write an entire natural history. If the work before us reach a second edition, the best thing the author can do is to invoke the assistance of a coadjutor who knows at least something about mammals.

R. L.

PHOTOGRAPHY.

The American Annual of Photography, 1914. 328 pages. Numerous illustrations. $8\frac{3}{4}$-in. × 6-in.

(George Routledge & Sons. Price 75 cents, or 3/6.)

This annual is of the class in which the articles and illustrations are contributed by photographic workers who have responded to an invitation to send a paper telling of experience, or experiments, in any branch of photographic work, or to send prints for illustration. There are over fifty contributed articles. The annual is not a "text book," but the papers contain a great deal of information, and also personal experiences, written in an interesting and captivating manner, which cannot be otherwise than helpful to one who, whether a novice or an advanced student in the art, would like to know something of the work and experiences of others. We are pleased to find an old acquaintance amongst the contributors: Mr. E. J. Wall, F.R.P.S., who gives a formula for a developing solution which the writer believes to be the same as that which he advocated before he took up his residence on the other side of the Atlantic.

The book is profusely illustrated with impressions from half-tone blocks, which comprise a variety of subjects and styles. Amongst the illustrators are the names of some whose work is well-known in this country.

A "Formulary" is appended with a head-note stating that the formulae are selected, not from "makers' formulae," but from the working methods of practical photographers. This is supplemented by a collection of useful tables, and a list (which is admitted to be incomplete) of American photographic societies. The book is not overcrowded with advertisements, and is worthy of a place in any photographer's library.

J. W.

PHYSICS.

Practical Exercises in Heat.—By E. S. A. Robson. 213 pages. 94 figures. $7\frac{1}{2}$-in. × 5-in.

(Macmillan & Co. Price 3/6.)

This useful book, after several reprints, appears in a second edition. Many additions have been made both to the experiments and to the examination questions, while the very convenient tables at the end have been carefully revised and extended. A more complete practical manual would be difficult to find.

W. D. E.

Mechanics and Heat.—By J. Duncan. 381 pages. 314 diagrams. $7\frac{1}{2}$-in. × 5-in.

(Macmillan & Co. Price 3/6.)

This book appears to contain the substance of the author's "Applied Mechanics for Beginners," with the addition of an elementary treatise on Heat, written from the point of view of the practical engineer, and eminently suitable for the student who wishes to become acquainted with the more practical applications of the subject. The chapters at the end on locomotive engines, small steam engines, and motor engines are attractive and likely to be useful.

W. D. E.

Sound (Cambridge Physical Series).—By J. W. Capstick. 296 pages. 120 figures. $7\frac{1}{2}$-in. × 5-in.

(The Cambridge University Press. Price 4/6.)

The study of acoustics has fallen out of the ordinary school course of physics ever since the Army examinations

ceased to include Sound as a subject. Moreover, at Cambridge it has been customary to regard the ability to perform experiments in sound as "the gift of God." Certainly we have had to wait a long time for a textbook more elementary than Lord Rayleigh's great work. The latest addition to the well-known series, which includes Glazebrook's "Heat and Light," will be welcome both to students of physics and of music, and is a worthy member of the family. It is surprising to find no reference to Professor Wood's photographs of sound-waves.

W. D. E.

REFERENCE BOOKS.

The New Encyclopædia.—Edited by H. C. O'NEILL. 1626 pages. Illustrated. 10¼-in. × 7-in.

(T. C. & E. C. Jack. Price 7/6 net.)

In the twentieth century it seems a brave thing to attempt to compile an encyclopaedia which shall not exceed in dimensions a single handy volume, but Mr. O'Neill has managed, with the help of his staff, to give brief explanations of hosts of words, things, people, and places which will serve to refresh the memory of many, and to give just that amount of explanation which may be necessary at the moment in connection with some matter of everyday interest. We have looked up a number of subjects, and have found some which we did not expect to see, while we have been surprised at the amount of space that it has been possible to give to scientific and natural history matters. "The New Encyclopaedia" should be on everyone's writing-table.

W. M. W.

WILD LIFE IN CRETE.

Camping in Crete, with Notes upon the Animal and Plant Life of the Island.—By AUBYN TREVOR-BATTYE, F.R.G.S. 308 pages. 32 plates. 9-in. × 5½-in.

(Witherby & Co. Price 10/6 net.)

It is with great pleasure we welcome another work by the author of "Ice-bound on Kolguev" (1895), for few writers wield a more facile pen in the description of scenery and wild life than Mr. Trevor-Battye, who, moreover, has the further advantage of being a trained and observant field naturalist, and is also, as demonstrated by the beautiful plates in the work before us, an adept in the use of the camera. Despite the researches of Sir Arthur Evans amid the ruins of the pre-Roman city of Knossos, of Professor Keller's investigations with regard to the connection between the extinct wild bull and the legend of Theseus and the Minotaur, and the explorations of Miss Dorothea Bate (who contributes an appendix to the volume) in the caverns of the island, Crete still remains an unknown land to the great majority of Englishmen. The reason for this, the author suggests, is that, although the island lies so close to the track of eastward-bound liners that its snowy peaks may be seen from their decks, yet it is awkward to approach, so that it is visited by few English people save archaeologists. Nevertheless he has little doubt that it will some day be "discovered," and become a more or less popular resort, as, indeed, from its climate and scenery, it has full claim to be.

Although the author says he has no concern with either antiquaries or politicals, yet he cannot help alluding to the present status and future political prospects of the island, whose inhabitants, after having thrown away a chance of stable settlement, now dream they will be happy in the arms of Greece!

To follow Mr. Battye in his wanderings from village to city, and from valley to mountain, is incompatible with the space at our disposal, and it must suffice to state that his narrative and illustrations collectively form one of the most delightful books of modern travel it has been our good fortune to peruse. To the naturalist the author's notes on the birds and the flora of the island, and those on the mammals by Miss Bate, will not fail to appeal; the special features of the mammal fauna being the occurrence of peculiar species of wild cat, weasel, and spiny mouse, the last of these belonging to a genus elsewhere known only from Africa, Cyprus, and Asia Minor.

R. L.

ZOOLOGY.

The Snakes of Europe.—By G. A. BOULENGER. 269 pages. 14 plates. 42 figures. 7½-in. × 5-in.

(Methuen & Co. Price 6/-.)

Mr. Boulenger has not only given an account of the snakes of Europe, but he has by way of introduction prepared a dozen or more chapters dealing with the whole subject of snakes, their classification, structure, habits, and distribution. His remarks on the relation of the reptiles to man include an account of snake-charmers. Mr. Boulenger says it is a mistake to think that a deadly snake is rendered harmless through the poison-fangs having been extracted, although this subterfuge is frequently resorted to by the less-accomplished jugglers. The immunity of the snake-charmer, we are told, is explained by the fact that the man has submitted himself to a series of successive graduated inoculations of the venom, a process similar to vaccination, which renders his blood proof against the venom of the particular species of snake—and that one only—which is used for his performances. More than twenty thousand human lives are lost every year in India through snake-bites. The only effective antidote is a serum produced from an animal which has been treated for some time with the venom of a poisonous snake, and which is antitoxic towards the poison of that particular species. The results would be greater if the venoms could be obtained in sufficient quantity to immunise the animals required, for a different serum is wanted in the case of each poisonous snake. In England instances of death from the bite of the viper are very few and far between, but in France and other Continental countries there are several fatal cases every year.

With regard to the systematic part of the book it is worthy of note that there is no work in the English language dealing with the reptiles of Europe, and therefore Mr. Boulenger's account of the snakes is of particular importance and value.

W. M. W.

Our Common Sea Birds.—By PERCY R. LOWE. 310 pages. Numerous illustrations. 12-in. × 8½-in.

(Country Life. Price 15/- net.)

This is the first of two volumes which are to deal with our common sea birds, and the present book touches on cormorants, terns, gulls, skuas, puffins, and auks. The pictures are by many well-known bird photographers, and those at the beginning of the book, which illustrate the flight of birds, are particularly striking. We also commend to our readers the figures of guillemots, razorbills, and puffins.

W. M. W.

CORRESPONDENCE.

EROSION.

To the Editors of "KNOWLEDGE."

SIRS,—I have been struck by some remarks in the Notes on Geology ("KNOWLEDGE," Volume XXXVII, page 31) with reference to Erosion and the Age of the Earth. It is there argued that the rate at which erosion works must be estimated in the basins of those rivers where man is scarce or absent rather than in those where man is settled in large numbers, because man himself is a powerful agent in increasing the rate of erosion through cultivation. The Ganges and Mississippi are mentioned as useless for purposes of calculation owing to the dense population dwelling on their banks, and the Rio Grande is suggested as the normal type from which an accurate estimate of the rate of erosion can be made.

I have no argument to advance as to the age of the Earth, nor do I wish to deny the fact that cultivation may to some extent tend to raise the rate of erosion. But is not the converse proposition, namely, that man has tended to settle where the rate of erosion is greatest, much more in accordance with facts? A high rate of erosion is usually coincident with a heavy rainfall, and these two facts together tend to make the wide fertile plains which naturally are the chief habitat of man on this Earth. Is not the vast population supported on the plains of the Ganges the result rather than the cause of the speed of erosion in those parts bringing fertility in its wake? Would the immigration of any number of men to the Rio Grande Valley appreciably affect the rate of erosion? Is it not rather true that the slowness of erosion in those parts consequent on the low rainfall precludes the settlement of man in any great numbers?

The writer of that paper's arguments for the Age of the Earth seem to me of as little value as those of other men of science of whom he makes ridicule.

The Notes above referred to, together with the Notes on Meteorology immediately following, which record some rainfalls in America and England, reinforce my opinion that English scientific men are apt to base their conclusions with regard to erosion on what they see in Great Britain rather than on what they see in many other parts of the world. The normal rate of erosion will appear very different if it is estimated from the Perthshire mountains, where the scratches of the Ice Age are still in evidence on the mountain-tops, or from such a place as Japan, where I have seen a valley which I estimated at forty feet deep filled up with detritus in a space of twenty-four hours, so that the stream at the bottom overflowed and took a new course on the other side of a large hill. This was the result of twenty-five inches of rain falling in twenty-four hours, and I can well remember standing on a hill a few days later from which full fifty scars were visible on the surrounding mountains, each one the result of a landslip. I have not the records by me just now, but, if I remember aright, the Government estimate was that eighteen thousand landslips took place as the result of that one storm; any estimate of the amount of soil carried down to a lower level (from a height chiefly above the ordinary human habitation) would be impossible; but I suppose erosion accounted for more in that one day in Japan than it has in Great Britain in the last hundred years.

It may interest your readers to know the rainfall as measured then by a Beck's automatic rain-gauge. During the first half of the month (August, 1910) the daily fall in inches was as follows: ·11, ·30, ·50, 1·45, ·35, ·80, ·93, 2·46, 9·00, 20·58, ·02, 1·55, 10·92, ·93, ·98, 1·54, or well over fifty inches in the fortnight. These records were made at nine a.m. each day. The heaviest rain ceased at an early hour in the morning, and, as stated above, during the last twenty-four hours of rain twenty-five inches fell.

During the same days this year in Japan my rain-gauge only registered ·67 inch altogether!

With apologies for trespassing so much on your space.

J. GURNEY BARCLAY.

MATSUYE,
JAPAN.

GRAVITATION

To the Editors of "KNOWLEDGE."

SIRS,—Mr. Cairns's essay on gravitation in the February number of "KNOWLEDGE" is very interesting, but he, like Le Sage, in trying to account for gravitation whose force is a pull, has fallen back on similar "multitudinous ubiquitous," and mythical flying particles, which are now named electrons, and the force of which could only be a push. If Newton had but accepted the vibration theory instead of the emission, he would assuredly have told us that vibration is the origin of gravitation.

Gravitation is not intermittent, but is a constant force; and as no force can act except through the medium of material, and as there is no material between us and the Sun but the aether, and as the aether has no movement but vibration, solar gravitation must be a constantly re-curring vibration of the aether—due either to the vibrations that are known to be sent to us from the Sun, or to some other set that is unknown—and it is extremely unlikely that terrestrial gravitation should differ from this in any way.

We cannot see the vibrations of aether or their action on material, so we must judge of these by the actions of such vibrations as are sensible to us, and the following are examples of such vibrations and of their effects.

Two men holding the ends of a rope will be drawn towards each other if they send a vibration along the rope.

On occasions when disastrous explosions have occurred, it has been noticed that the windows of houses have—as it has been described—been blown out. The first severest part of the sound vibration drew them towards the point of origin of the sound.

Ripples in water draw small floating objects together, and Professor Bjerkness found by experiment that elastic bodies immersed in water and made to pulsate are drawn towards one another.

The vibrations of electricity and magnetism are due to particular activity, and produce actions of attraction and repulsion in no way resembling gravitation, so they cannot be referred to in regard to our subject. In all the instances given, the pull is due to a force of vibration acting across the line of pull. The aether vibration is said to be a cross vibration, and should therefore also produce a pull; but to understand how it acts is exceedingly difficult, if one endeavours to realise what its system of wave motion is from a study of the published descriptions given, which indeed, speaking personally, are unintelligible; and it is hoped that the following more simple simile may be more illuminating.

Supposing that a tube of very thin, flexible rubber were suspended by one end, and that a bullet were dropped down it, the course of the bullet would be shown outside as a swelling of the tube in the shape of an egg with tapered ends; and if other bullets were dropped in at correct intervals the swellings would follow one another in such a way that an outline drawing of any side of the tube would show the ordinary conventional wavy line that represents wave motion.

There are evidently two forces acting on the tube, a progressive force in the line of direction of the wave and a transverse force across that line; and the transverse force must draw whatever the wave acts on towards the point of origin of the wave.

The aether wave differs then in no way from the ordinary wave, except that, being confined to no surface but free all round, its crest rises as a ring at right angles to its line of direction.

With such an aether wave all the puzzles of polarisation of light are easily explained.

The aether has no weight of material that can make the propulsive force of its waves felt, but its transverse wave force can and does, as we know, act on the molecules of matter, and the first part of its action is to draw the molecule towards the point of origin of the aether wave—and this is gravitation.

It appears then that every aether wave should produce gravitation, and acting on every substance should cause those mutual attractions that pass under such names as cohesion, contraction, affinity, crystallisation, and so on, and in every case the amount of mutual force is $\frac{G \times g}{d^2}$.

The above solution has been put as simply as possible, but it must not on that account be supposed to be a mere light guess, for it was arrived at only after much study of the subjects connected with wave motion, and especially that of the polarisation of light.

W. F. BADGLEY.

DEVIZES.

THE FACE OF THE SKY FOR APRIL.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 13.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	[illegible] R.A.	[illegible] Dec.	N[illegible] R.A.	N[illegible] Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Apr. 3	[illegible] 47·4	N. [illegible]	[illegible] 4 [illegible]	N. [illegible]	[illegible]	S. 7·[illegible]	1 [illegible]·4	N. 9·1	7 1[illegible]·2	N. 24·[illegible]	21 [illegible]	S. [illegible]·7	4 4[illegible]	N. 21·[illegible]	7 [illegible]	N. 20·7
,, 8	1 [illegible]	[illegible]	11 1[illegible]	N. 4[illegible]	[illegible] 2[illegible]	[illegible]	1 53·7	11·5	7 25·[illegible]	24·4	21 16·[illegible]	17·4	4 5[illegible]	21·2	7 4[illegible]	20·7
,, 13	1 4[illegible]	[illegible]	15 [illegible]	[illegible]	[illegible] 43·6	[illegible]	2 22·2	13·7	7 34·2	24·0	21 19·[illegible]	1[illegible]	4 [illegible]	21·[illegible]	7 4[illegible]	20·7
,, 18	1 4[illegible]	1[illegible]	[illegible]	S. [illegible]	[illegible] 13·5	N. 1·4	2 49·2	15·8	7 43·5	23·5	21 22·6	16·5	4 5[illegible]	21·[illegible]	7 4[illegible]·4	20·7
,, 23	[illegible]	12	[illegible]	N. [illegible]	[illegible] 4[illegible]	N. 1·[illegible]	3 10·5	17·7	7 53·5	23·1	21 25·4	15·5	4 57·[illegible]	21·4	7 4[illegible]	20·6
,, 28	[illegible]	N. 14	4 [illegible]	N. [illegible]	1 1[illegible]·7	N. 4·6	3 3[illegible]·4	N. 19·5	8 [illegible]	N. 22·4	21 28	S. 1[illegible]	4 [illegible]	N. 21·[illegible]	7 4[illegible]	N. 20·6

TABLE 14.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	h. m.	°	°	°	°	h. m.	h. m.
Apr. 3	−26·3	−5·4	[illegible]2·7	−[illegible]	−15·2	+7·0	[illegible]3·4	7 34 *m*	−19·3	−0·2	310·2	21·7	3 2[illegible] *m*	6 11 *m*
,, 8	25·4	6·1	[illegible]·7	−21·5	15·0	7·[illegible]	15·6	10 54 *m*	19·5	0·2	19·2	241·0	9 18 *e*	3 15 *e*
,, 13	26·3	5·7	224·7	+13·[illegible]	13·8	8·6	328·3	2 1[illegible] *e*	19·7	0·1	85·3	272·4	9 34 *m*	4 28 *m*
,, 18	26·5	5·3	255·0	−14·0	12·5	9·8	280·7	5 25 *e*	20·0	0·1	157·4	303·4	5 37 *e*	11 29 *e*
,, 23	25·5	4·[illegible]	1[illegible]2·0	−21·8	11·2	10·7	232·0	8 42 *e*	20·2	0·1	226·5	334·4	5 43 *m*	0 41 *e*
,, 28	−24·8	−4·[illegible]	126·6	−5·4	−9·8	+11·7	185·0	11 52 *e*	−20·3	−0·[illegible]	295·5	5·5	11 35 *e*	1 54 *m*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II. to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}7$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN continues its Northward march but with slackening speed. Its semi-diameter diminishes from 16′ 2″ to 15′ 54″. Sunrise changes from $5^h\ 40^m$ to $4^h\ 38^m$; sunset from $6^h\ 30^m$ to $7^h\ 18^m$.

MERCURY is a morning star. Semi-diameter $3\frac{1}{2}$″. Illumination increases from $\frac{2}{5}$ to $\frac{3}{4}$. At West Elongation (27° 46′) $7^d\ 7^h$ *m*.

VENUS is an evening star, but still too near the Sun for convenient observation. Disc practically full. Semi-diameter 5″. Superior conjunction was on February 11th.

THE MOON.—First Quarter $3^d\ 7^h\ 41^m$ *e*; Full $10^d\ 1^h\ 28^m$ *e*. Last Quarter $17^d\ 7^h\ 52^m$ *m*. New $25^d\ 11^h\ 22^m$ *m*. Perigee $10^d\ 10^h$ *m*. Apogee $23^d\ 5^h$ *e*, semi-diameter 16′ 46″, 14′ 43″ respectively. Maximum Librations, 1^d 7° S, 4^d 8° E, 14^d 7° N, 16^d 8° W, 28^d 7° S, May 2^d 7° E. The letters indicate the region of the Moon's limb brought into view by libration. E. W., are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 16.)

MARS is slowly advancing. It is about $4\frac{1}{2}$° South of Pollux on 16th, $2\frac{1}{2}$° North of Neptune on 21st. Near Moon on 4th, 3^h *m*. It will be seen that both hemispheres of Mars are observable, but the Northern one is best placed. The semi-diameter during April diminishes from 4″ to 3″. The unilluminated lune is on the East: its width diminishes from $\frac{4}{10}$″ to $\frac{6}{10}$″.

JUPITER is still rather badly placed, having been in conjunction with the Sun on January 20th. It is a morning star. Polar semi-diameter, 17″.

Configuration of satellites at 4^h *m* for an inverting telescope

TABLE 15.

Day	West.		East.		Day.	West.		East.	
Apr. 1	4231	○			Apr. 16	2	○	41	3●
,, 2	4	○	13	2●	,, 17	41	○	23	
,, 3	4	○	23	1●	,, 18	4	⊙	13	
,, 4	421	○	3		,, 19	42	○	13	
,, 5	42	○	31		,, 20	431	○	2	
,, 6	431	○	2		,, 21	43	○	12	
,, 7	34	○	21		,, 22	4321	○		
,, 8	3214	○			,, 23	42	○	1	3●
,, 9		○	314	2●	,, 24	41	○	23	
,, 10	1	○	234		,, 25		○	213	4●
,, 11	2	⊙	34		,, 26	2	○	34	1●
,, 12	2	○	134		,, 27	31	○	24	
,, 13	31	○	24		,, 28	3	○	124	
,, 14	3	○	124		,, 29	321	○	4	
,, 15	321	○	4		,, 30	23	○	14	

The following satellite phenomena are visible at Greenwich, all in the morning hours, $2^d\ 4^h\ 53^m\ 56^s$ II. Oc. R.; $4^h\ 58^m\ 55^s$ I. Sh. I.; $3^d\ 5^h\ 33^m\ 13^s$ I. Oc. R.; $8^d\ 4^h\ 21^m\ 39^s$ IV. Oc. D.; $10^d\ 4^h\ 0^m\ 52^s$ I. Ec. D.; $11^d\ 3^h\ 36^m\ 27^s$ I. Sh. E.; $4^h\ 46^m\ 43^s$

I. Tr. E.; $16^d\ 5^h\ 0^m\ 23^s$ II. Ec. D.; $18^d\ 3^h\ 14^m\ 19^s$ I. Sh. I.; $4^h\ 27^m\ 48^s$ I. Tr. I.; $4^h\ 49^m\ 0^s$ II. Tr. E.; $19^d\ 3^h\ 58^m\ 31^s$ I Oc. R.; $25^d\ 4^h\ 23^m\ 38^s$ IV. Oc. R.; $4^h\ 30^m\ 30^s$ II. Tr. I.; $27^d\ 3^h\ 8^m\ 19^s$ I. Tr. E. Attention may be called to the fact that Professor R. A. Sampson's new tables of Jupiter's satellites are used for the first time in the Nautical Almanac; we may expect a considerable increase of accuracy in the predictions.

The eclipses will take place to the left of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN is approaching the Sun, but is still observable as an evening star. Polar semi-diameter 8″. P. is $-4°·5$; B $-26°·8$. Ring major axis 40″, minor 18″. The ring is approaching its maximum opening, and projects beyond the poles of the planet. It is interesting to measure the exact amount of overlap. The absolute maximum opening will occur on June 1st, but the Planet will then be too near the Sun to see.

East Elongations of Tethys (every fourth given), $3^d\ 3^h·1m$, $10^d\ 4^h·4e$; Dione (every third given), $2^d\ 10^h·7e$, $11^d\ 4^h·0m$; Rhea (every second given), $2^d\ 11^h·7m$, $11^d\ 0^h·8e$. For Titan and Iapetus E.W. mean East and West Elongations; I. Inferior (North) Conjunctions, S. Superior (South) ones. Titan, $2^d\ 9^h·4e$ S., $7^d\ 0^h·6m$ E., $11^d\ 0^h·5m$ I., $14^d\ 9^h·5e$ W.; Iapetus, $15^d\ 2^h·9e$ E.

URANUS is a morning star, but badly placed, having been in conjunction with the Sun on January 28th. It was 9′ south of Jupiter on March 4th.

TABLE 16. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1914			h. m.		h. m.	°
April 3	BD + 20 1481 ...	7·0	11 3 *e*	82°	—	—
.. 6	Wash. 630 ...	6·7	2 23 *m*	112	—	—
.. 7	Regulus	1·3	3 27 *m*	117	4 16 *m*	296
.. 8	50 Leonis	6·1	0 36 *m*	118	1 36 *m*	310
.. 8	Wash. 750	6·8	7 3 *e*	63	—	
.. 10	BD − 12 3830 ..	6·8			8 13*e*	4
.. 11	85 Virginis	6·1	3 36 *m*	90	4 33 *m*	320
.. 11	BAC 4814	6·5	10 10 *e*	105	11 13 *e*	310
.. 14	BAC 5003 ...	6·0	0 22 *m*	124	1 29 *m*	266
.. 20	BAC 1848	5·6	7 15 *e*	72	8 12 *e*	205
.. 20	136 Tauri	4·6	8 31 *e*	137	9 16 *e*	239
.. 29	BAC 1018 ..	6·1	11 29 *e*	89	0 17* *m*	283

The asterisk indicates the day following that given in the date column.

From New Moon to Full disappearances occur at the Dark Limb, from Full to New reappearances.

Attention is called to the occultation of Regulus on 7th: the star is low in the west.

TABLE 17. NON-ALGOL STARS.

Star.	Right Ascension	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
RX Virginis ...	12 0	− 5 ·3	7·4 to 9·0	irregular	
RW Virginis	12 3	− 6 ·3	6·8 to 7·7	irregular	
T Virginis	12 10	− 5 ·5	8·2 to 13·4	339·5	April 20.
RY Urs. Maj.	12 16	+61 ·8	7·2 to 8·3	315	About April.
SS Virginis ...	12 21	+ 1 ·3	7·2 to 9·0	unknown	
Y Virginis ..	12 30	− 3 ·9	8·5 to 13·4	218·8	May 5.
T Urs. Maj.	12 33	+60 ·0	5·5 to 12·7	257·2	May 16.
R Virginis ..	12 34	+ 7 ·5	6·2 to 11·1	145·5	February 21.
RV Draconis	12 34	+60 ·1	8·4 to 13·6	205	February 18.
Y Urs. Maj. ...	12 36	+56 ·3	7·7 to 9·3	irregular	
S Urs. Maj. ...	12 40	+61 ·6	7·0 to 12·5	226·5	April 24
Y Can. Ven. ...	12 41	+45 ·9	4·8 to 6·0	unknown	
RY Draconis ..	12 53	+66 ·5	6·1 to 7·1	irregular	
SW Virginis	13 10	− 2 ·3	7·4 to 8·8	irregular	
V Can. Ven.	13 16	+46 ·0	7·5 to 8·0	unknown	
V Virginis ..	13 23	− 2 ·7	8·0 to 13·8	250·5	April 23.
R Hydrae	13 25	−22 ·8	3·5 to 10·1	425·15	June 4.
T Urs. Min.	13 33	+73 ·9	8·8 to 13·9	321	February 10.
V Urs. Min.	13 37	+74 ·7	7·5 to 8·7	71	March 18, May 28.
R Can. Ven.	13 45	+40 ·0	7·4 to 12·2	328	April 30.

Principal Minima of β Lyrae April $12^d\ 6^h e$, $25^d\ 4^h e$. Period $12^d\ 21^h·8$.

Algol minima Apr. $6^d\ 1^h\ 24^m m$, $8^d\ 10^h\ 12^m e$, $11^d\ 7^h\ 6^m e$, $14^d\ 3^h\ 54^m e$, $26^d\ 3^h\ 6^m m$, $28^d\ 11^h\ 54^m e$. Period $2^d\ 20^h\ 48^m\ 55·6^s$.

Mira Ceti reaches maximum on March 17th. Mag. 2·0; it is, however, too near the Sun for convenient observation.

NEPTUNE was in opposition on January 17th. Semi-diameter 1″. Possessors of small telescopes may easily recognise it by its motion, if they make a sketch map of the stars in the region, and observe it night by night. It is 2½° south of Mars on 21st.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable. (See Table 17.)

METEOR SHOWERS (from Mr. Denning's List).

Date.	Radiant.		Remarks.
	R.A.	Dec.	
Mar. May	203	+ 62	Rather swift.
Apl. 12-24	230	10	Slow, fireballs.
„ 16-25	321	+ 23	Swift, streaks.
„ 18-23	180	31	Slow, long.
„ 20-21	26	- 30	Swift, bluish white.
„ 20-22	271	33	Conspicuous shower, swift.
„ 20-25	218	31	Slow, long paths.
„ 30	201	+ 59	Rather slow.
Apl.-May	103	55	Slow, yellow.
Apl.-May ..	200	+ 0	Swift, streaks.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

OBITUARY.—I have been discussing Sir David Gill's History of the Cape Observatory" in several recent numbers of "KNOWLEDGE." I have now to turn from it to record his lamented death, which removes one of the most conspicuous figures from the ranks of British astronomers. He was present at the meeting of the Royal Astronomical Society in December, and appeared in his usual health and spirits; but almost immediately after it he was attacked by pneumonia, and after a long struggle he succumbed. He may be said to have died in harness, for though he retired from the Cape Observatory in 1906, after twenty-eight years of strenuous service, his boundless energy led him to take an active part in the work of many scientific bodies, which will feel his loss acutely. M. Baillaud is coming to the March meeting of the Astronomical Society to express the grief felt among foreign astronomers at his death, and their sense of his great services to Astronomy, more especially in the matter of the Astrographic Chart. It will be remembered that it was the success in photographing faint stars on the Cape photographs of the Great Comet of 1882 that led to the Paris Conference of 1887, and the subsequent partitioning of the whole sky among twenty observatories. A project having some connection with this, which Gill carried through in conjunction with Kapteyn, was the Cape Photographic Durchmusterung, by which the southern hemisphere, so long neglected, was surveyed in a more accurate manner than the northern. Gill's tenure of office was indeed a memorable epoch in southern astronomy, and will be remembered as long as the science exists.

Another well-known astronomer is dead, Professor S. C. Chandler, at the ripe age of eighty-six; he is best known for his discovery of the variation of latitude. Previous inquirers into this subject had been baffled by the false assumption that the period of the variation must be three hundred and five days. Chandler boldly put this aside, and finally found that two waves could be traced—one with a period of fourteen months, the other of a year. After these had been announced Professor Newcomb showed that the three hundred and five day period involved the assumption that the Earth was perfectly rigid; a rigidity about equal to steel would explain the fourteen-month term; this has since been verified in other ways. Dr. Chandler received the Gold Medal of the R.A.S. for this discovery. He is also well known for his work on variable stars, of which he published several catalogues. He is also known for his invention of the Almucantar, an instrument that floats in a circular trough of mercury, enabling the transits of stars over a horizontal circle to be observed. One of these instruments is mounted at Durham Observatory and its results form a useful check on those made with meridian instruments.

The Rev. Edmund Ledger is also dead: he was the Gresham lecturer on Astronomy for many years, and also published an attractive text-book on the Solar System. I have no doubt that his books and lectures are familiar to many of our readers.

THE TOTAL SOLAR ECLIPSE OF AUGUST 21ST NEXT.—Mr. Chambers, at the January meeting of the B.A.A., emphasised the necessity that those intending to view this eclipse should make their arrangements within the next month, as the accommodation along the route is limited. Those going to Norway will probably have to sleep on board ship, as there are no considerable towns within the shadow-track. I understand that the Royal Mail Steamship Company announce a fortnight's trip, including some hours ashore on the island of Alsten on the day of the eclipse, for a minimum charge of £15. It is also possible to go to Hernosand, on the Baltic coast of Sweden: this can be reached by local steamer from Stockholm, and contains suitable hotels. The eclipse may also be seen from the Aland Islands, or Dago or Oesel, but the accommodation for tourists is probably primitive. In Russia the most accessible points are Riga, Minsk, Kiev, and the Crimea. Riga can easily be reached from England by the Wilson Line, the return fare, including board, being about £15. I am informed that the accommodation at Riga is likely to be strained to the utmost by the invasion of sightseers, so it is imperative to engage rooms in good time. Those intending to view the eclipse would do well to communicate with Mr. G. F. Chambers, Lethen Grange, Sydenham, who is secretary of the committee appointed by the B.A.A. to organise the expeditions. The duration of totality is about two minutes; the height of Sun 39°. The eclipse is about one p.m. in Norway and two p.m. in Russia. Three official parties will go from England to view the eclipse in Russia, occupying Kiev, Minsk, and Feodosia (Crimea) respectively. All will undertake photography of the corona, both small-scale pictures for the extensions, and large-scale for details of arches, and so on. The Minsk party will also study the distribution of the gas "Coronium," using a screen of "Mercury Green" glass. They will also pay special attention to the ultra-violet region of the coronal spectrum, using a quartz spectrograph. On the other hand, Fathers Cortie and O'Connor, at Kiev, will pay special attention to the yellow and red part of the spectrum, Messrs. Curtis, Fowler, and Hills, at this station, will take large-scale high dispersion photographs of the spectrum of the Chromosphere during the partial phases, using an iron-arc comparison spectrum. The possibility of this work was shown at the eclipse of April, 1912. At the last Russian totality, in 1887, the weather conditions were discouraging, but the Sun's altitude will be much greater next summer, and the parties will also be more divided, so that complete failure is unlikely.

DELAVAN'S COMET.—The orbit of this comet that was given last month proved to be much in error. The real orbit is of a much more interesting character, and indicates that when discovered the comet was at more than four times the Earth's distance from the Sun; in fact, quite near the orbit of Jupiter. It will not make its nearest approach to the Sun till eleven p.m. on October 26th, that distance being 1·1053 in astronomical units, or one hundred and three million miles; the ascending node is in longitude 59° 10', the arc from node to perihelion is 97° 27', and the inclination to the ecliptic 68° 6'. The comet will be at its greatest distance north of the ecliptic about the time of perihelion, which will make the conditions of observation much better for northern observers. There is little doubt that it will be a naked-eye object in September and October, and it may possibly become extremely brilliant; but it is better not to be too sanguine on this point. The following ephemeris is for Greenwich midnight:—

	R.A.		N.Dec.		Log r.		Log Δ.
	h. m. s.		° '				
Mar. 5 ...	2 44 2	...	4 31	...	0·5343	...	0·5882
,, 13 ...	2 47 38	...	6 0	...	0·5232	...	0·5904
,, 21 ...	2 52 4	...	7 30	...	0·5116	...	0·5915
,, 29 ...	2 57 13	...	9 1	...	0·4996	...	0·5912
April 29 ...	3 23 48	...	15 7	...	0·4492	...	0·5775
May 29 ...	3 58 36	...	21 26	...	0·3935	...	0·5419
June 28 ...	4 45 36	...	28 46	...	0·3271	...	0·4797
July 28 ...	5 53 6	...	37 40	...	0·2507	...	0·3901
Aug. 27 ...	7 53 12	...	47 33	...	0·1643	...	0·2807
Sept. 26 ...	11 25 20	...	47 2	...	0·0819	...	0·2022
Oct. 26 ...	14 12 4	...	26 34	...	0·0435	...	0·2259
Nov. 25 ...	15 38 0	...	6 16	...	0·0822	...	0·2991

It will be seen that the comet is too near the Sun for visibility in April, May, June. Then it will reappear as as a morning star; but by mid-August it will become circumpolar, and therefore observable all night. It will, however, be best placed just before the dawn. The nearest approach to the Earth will be early in October, the distance being 1·58 astronomical units. On the day of perihelion the comet will be about 7° north of Arcturus. This reminds us of the conjunction of Donati's comet with Arcturus in October, 1858.

THE REMARKABLE QUIESCENCE OF THE SUN.—Mr. E. W. Maunder points out that 1913 was absolutely the quietest year since 1810. The number of days when the Sun was free from spots in 1911, 1912, 1913 was 183,246,310. The mean daily spotted area, measured in millionths of the visible hemisphere, comes out 64, 37, 5 in the three years; the numbers of separate groups are 62, 39, 15; thus in every way activity has declined. The most considerable group appeared on December 30th. Two out of every three of the groups observed last year appear from their high latitudes to belong to the new cycle; the others, being near the Equator, belong to the expiring one. As the new cycle has already been running for one and a quarter years it would seem to promise little in the way of activity.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

SYMBIOSIS BETWEEN ALGAE AND SPONGES.—In the course of a paper on Red Algae from Queensland, Cotton (*Kew Bulletin*, 1913, No. 7) describes some interesting cases of Algae living in symbiosis with sponges. Even in the temperate regions, as on the British coast, carpets of short filamentous Algae are often seen to be in competition with the encrusting sponges which grow in caves and other dark recesses on the shore. In some cases accidental concrescence of the two organisms is observed, in others such association is more constant and intimate. A further and more advanced state of union is met with in the sponge *Halichondria panicea*, which is at times completely invaded by a green filamentous Alga; the external form of the sponge remains unchanged, but infected sponges are recognised by their green colour.

In the tropical seaweed *Thamnoclonium Tissotii*, however, the Alga is the dominant partner, the sponge growing symbiotically on the surface of a large foliaceous thallus. This seaweed, formerly known from the tropical Kei Islands, is now described from Queensland. The thallus consists of large flattened lobes, and both surfaces are completely clothed with a thin sponge, into which penetrate filaments given off from the outer layer of the Alga. The external appearance of the dual organism is that of old faded fronds, but a section shows the sponge with its clusters of projecting spicules.

The seaweed *Ceratodictyon spongiosum* differs from all previously recorded cases of Algae living in symbiosis with sponges in that a change of form is evidently induced through the commensal existence. The main segments of the thallus consist of very slender branches woven together to form a network, the interstices being filled up by the sponge, which also forms an investing coat around each segment. Hence the symbiosis is more intimate than in *Thamnoclonium*, and both organisms are materially modified in habit.

PIGMENTATION AND ASSIMILATION IN PLANTS.—A. von Richter (*Ber. d. deutsch. bot. Ges.*, Bd. 30, pp. 280–290) has made a thorough investigation of the process of assimilation in green, brown, and red Algae at Naples. The Algae were placed in large glass cylinders filled with sea-water of known carbon dioxide content; plants of the differently coloured Algae were exposed simultaneously, some to pure sunlight and others to coloured lights (obtained by interposing spectroscopically-pure coloured screens); while in other series of experiments the assimilation of green, brown, and red Algae in light of varying intensities was determined. At the end of each experiment the water was analysed for carbon dioxide, and the diminution of this gas and the increase in oxygen were noted. From the results the author concludes that the most important factor determining the rate of assimilation in differently coloured Algae is not the colour of the incident light, but its intensity; that among marine Algae, as among ordinary land plants, some species are light-loving and others light-avoiding, or, expressed in terms of Wiesner's *Lichtgenuss* theory, some require a relatively high light intensity and others a relatively low intensity; that the distribution of marine Algae in vertical zones is related to these differences as to *Lichtgenuss* in the different species; that the pigments additional to chlorophyll in Brown Algae (phycophaein), Red Algae (phycoerythrin), and Blue-green Algae (phycocyanin) play no active part in the process of assimilation; that this process is entirely attributable to the chlorophyll which is always present in Algae and all other plants capable of assimilation; and that the well-known and hitherto generally accepted "chromatic adaptation" theory of Engelmann requires thorough revision, since it does not account for, and is indeed rendered unnecessary by, the results obtained in the author's experiments.

VEGETATION ABOVE THE SNOW-LINE IN THE ALPS. Braun (*Ber. d. Naturforsch. Schweiz.*, 1913, 347 pp.) gives an interesting account of the nival (above snow-line) flora of the great mountain masses of South-eastern Switzerland, including the Lepontine Alps in the west, and the Rhaetian Alps in the east. His chief object is to present "a picture of plant life at its extreme limit," and though nearly half of his work, which has also been published in book form ("Vegetationsverhältnisse der Schneestufe in den Rätisch-Lepontischen Alpen," Georg and Co., Bâle, price 20 marks), is occupied by lists of species with their habitats, he has throughout dealt with the nival zone from an ecological rather than a floristic standpoint. The climatic snow-line, forming the lower limit of the nival zone, lies at about two thousand six hundred and fifty metres in the western (Sardona and Gotthard) region and at about two thousand nine hundred and sixty metres in the eastern (Bernina) region, and the flora of the nival zone in

the area investigated includes two hundred and twenty-four vascular plants. The author divides the plant associations into three main sub-zones :—(1) a lower, up to one hundred and fifty metres above the snow-line, dominated by grasses ; (2) a middle, up to five hundred and fifty metres above snow-line, characterised by Dicotyledons ; and (3) a summit flora devoid of flowering plants and consisting only of Thallophyta (Algae, Fungi, Lichens) which extend up to the highest peaks. Wind is one of the most important factors in the environment of the nival flora, and the author devotes an interesting chapter to the effects on the nival vegetation of the strong winds that prevail in the high Alps, especially in winter. The drying action of these winds excludes all except a few hardy species (*Saxifraga retusa, S. caesia, Androsace helvetica, Gentiana brachyphylla,* and so on) from the snow-free but exposed places. The low-growing tufted, patch-forming, and cushion plants are furrowed, undermined, and distorted by the mechanical action of the wind and the fine snow which it sweeps over the plants as a " snow-blast " comparable with the fierce sand-blast in deserts.

Other interesting sections are those dealing with the ripening, viability, and dispersal of the seeds of nival plants. The author finds that the conditions above snow-line are not so unfavourable for the ripening of seed as has usually been supposed, for in twenty-five species collected above three thousand one hundred metres the seeds were fully ripe and capable of germination, and he believes that the nival flora does not depend to any great extent upon the carriage of seeds from lower levels for its maintenance. Many of his observations are of considerable practical interest to those concerned with the collection and cultivation of alpine plants, though, of course, the great majority of the nival species also occur at lower elevations. In more than twenty per cent. of the nival species the fruits with their seeds remain on the plant over the winter, and in some cases for two or three winters, and the seeds in such cases show a higher germination capacity than seeds collected in the autumn after flowering. Shrubs like *Empetrum, Vaccinium* and *Juniperus* occur here and there in the nival zone, arising from seeds carried by birds, but they are usually dwarfed plants and are always sterile. From various facts and considerations which he brings forward the author concludes that in the Glacial period a relatively rich flora, similar to the nival flora of the present day, persisted in the interior of the Alps; for instance, there are certain nival species which have no special method of dispersal, and which show markedly discontinuous distribution; and these can hardly be regarded otherwise than as relict forms.

VEGETATION OF THE EAST FRISIAN ISLANDS.—Leege (*Abhandl. naturw. Ver. Bremen,* Bd. 21, 1913, pp. 283–327) deals in an interesting manner with what is always an interesting problem to biologists—the colonising of fresh ground by plants. He has for some years investigated the vegetation of the chain of small islands lying off the coast of East Friesland, between the estuaries of the Ems and Weser, and has noted various species, especially among cryptogams, additional to those recorded by Buchenau in his work (1881) on the vegetation of these islands. The paper cited above deals with one of the smallest islands, which is growing in extent and is still in process of colonisation by plants. According to the author's observations, water transport is the most important agent in the colonisation of the island by plants, and an examination of the drift and of the colonising species showed that to a large extent the plants had arisen from vegetative parts carried out to sea—the island investigated (Memmert) lies in the channel of the East Ems—rather than from seeds thus transported. He also considers that wind carriage of seeds has played a very small part, probably limited to the transport of the spores of mosses, ferns, lichens, and fungi, and the seeds of the three species of orchids found on the island. Among the fungi, *Phallus impudicus* is very common: its spores are carried by the butterfly *Vanessa antiopa.* The author ascribes to birds a large part in the carriage of dry as well as fleshy fruits and seeds. In his sketch of the development of the vegetation of Memmert from 1888 to 1912 the author notes that the present flora comprises one hundred and eighty-eight species, while twenty-nine of the early colonists have disappeared.

CHEMISTRY.

By C. Ainsworth Mitchell, B.A. (Oxon), F.I.C.

WHALE OIL AND ITS UTILISATION.—Until about seven years ago the demand for whale oil was relatively small, for it could only be utilised in the manufacture of glycerin and fatty acids and, to a limited extent, of soap. The objection to its use as the raw material for soap was its persistent odour, which could only be partially masked by the addition of other fats. By the discovery of the process of catalytic hydrogenation this drawback has been obviated, and enormous quantities of the oil are now made into soap. In the catalytic process, an outline of which has already been given in these columns, the oil is heated in a current of hydrogen, in the presence of palladium, nickel, or a similar catalytic metal, with the result that the liquid fatty acids absorb the hydrogen and are transformed into solid odourless compounds resembling tallow, the hardness of the product depending upon the duration of the hydrogenation.

The effect of this discovery upon the output of whale oil is shown by the increased price now obtained. According to Dr. H. Offerdahl-Larvik (*Ber. deutsch. Pharm. Ges.,* 1913, XXIII, 558) the total production of whale oil in 1912 was one million two hundred thousand barrels, more than half of which came from Norway. Ten years ago the cost of producing a ton of the oil was about £13 15s., but last year higher wages and higher prices for fuel had raised the cost to about £19 5s. per ton.

After separation of the oil the residual flesh and bones are dried, ground up, sifted, and mixed in suitable proportions to form an animal manure, containing ten to twelve per cent. of nitrogen and fourteen to fifteen per cent. of phosphoric acid, with about two per cent. of oil. A whale of average size will produce from forty to fifty sacks of such guano, which fetches about 5s. to 6s. per hundredweight. Although it is stated that solidified whale oil is used exclusively in the manufacture of soap, there can be but little doubt that sooner or later it will be employed as a raw material for substitutes for butter and lard. As these hardened oils invariably contain traces of the metal used in the hydrogenation, physiological experiments are needed to ascertain whether minute quantities of nickel or palladium would have any injurious effect upon the system if taken over a long period. According to Dr. Offerdahl-Larvik quantities of 0·5 gramme of nickel could be taken daily without ill effect, while 99·8 per cent. of the metal was rapidly excreted from the system ; but no details are given of the duration of the experiments or of the ultimate fate of the 0·2 per cent. of metal daily absorbed.

PERFUMES OF LICHENS.—Mr. E. M. Holmes, writing in the *Perfumer and Essential Oil Record* (1913, IV, 408), calls attention to the possibility of utilising the odorous principles of lichens in perfumery. For example, the common reindeer lichens (*Cladonia rangifera* and *C. sylvatica*) might be used as the basis of certain perfumes, in the same way as the " oak-moss " (*Evernia prunastri*) is used in France. This lichen usually occurs in association with other lichens, but is readily distinguished by its frond, being grey above and white beneath. It contains a phenol (*lichenol*) which is isomeric with carvacrol (the odorous principle of essential oils of the thyme family), and is soluble in a solution of sodium carbonate.

In France the perfume is extracted from this *mousse de chêne* by means of petroleum spirit, and the solvent is separated by evaporating the extract at a low temperature in a vacuum. The residue is then diluted with a suitable pro-

portion of alcohol, and incorporated with soap or blended with other essential oils for perfumes. According to Mr. H. Mann (*Amer. Perfumer and Essential Oil Review*, 1913, VIII, 248) the powdered lichen itself is also incorporated with soaps, with the object of imparting its scent and increasing the detergent properties of the preparation. Other lichens containing odorous principles are mentioned by Mr. Holmes. These include *Lobaria pulmonaria*, "oak-lungs," *Conocephalus conicus*, which has an odour of bergamot, and *Hygrophorus agathosus* with an aniseed odour, but the essential oils contained in these lichens have not yet been separated and identified.

ENGINEERING AND METALLURGICAL.

By T. Stenhouse, B.Sc., A.R.S.M., F.I.C.

PLATINUM METALS IN CUPELLATION BEADS.—The influence of small quantities of metals of the platinum group on the appearance of silver and gold buttons obtained by cupellation forms the subject of an interesting paper read before the Institute of Mining and Metallurgy by Messrs. C. O. Bannister and G. Patchin. (Through *Journal of the Society of Chemical Industry*, 1914, page 29.) Photographs of the surfaces of the buttons, taken under low magnifications, show that the characteristic appearances are clear and pronounced. Platinum, iridium, rhodium, and ruthenium all give rise to characteristic effects. Palladium gives results similar to those produced by platinum, but the presence of the former is very clearly revealed in the parting operation, as little as 0·0002 gramme of palladium imparting a yellow tint to the parting acid. Osmium, however, even when present to the extent of two per cent., has no effect on the appearance of the silver bead.

POROSITY OF IRON.—In the January number of *The Journal of the Chemical Society* Mr. W. H. Perkins describes the results of experiments designed to test the truth of the view that iron which has been immersed for some time in a solution of alkali hydroxide, and then thoroughly washed with water, still retains a small quantity of alkali in its pores. In addition to positive tests obtained with iron foil, the author found that a gold crucible which had contained lithium hydroxide for some months, after washing well for five or ten minutes with running water, required a daily change of water for more than four weeks before the spectroscopic test for lithium failed to show its presence in the water. From his experiments the author considers it is clear that traces of alkalis, and presumably, therefore, other solutions, are retained by metals in such a way that their extraction is a slow process of simple diffusion, and cannot be hastened by shaking or even by gentle rubbing. Whether this is due to actual porosity, or to the formation of a surface layer, is not quite clear, but the "absorption" is obviously very slight.

THE FUTURE OF OIL FUEL.—In his presidential address to the Junior Institute of Engineers, Sir Boverton Redwood discussed the probable development of the use of oil fuel. The demand which will have first to be met will be that of the belligerent navies of the world, since to them efficiency, rather than cost, is of paramount importance. The industrial use of oil fuel will depend to a large extent on the development of the internal combustion engine, since with the steam-engine not more than twelve per cent. of the energy of the fuel is ordinarily obtained in the form of work, whilst in the case of the Diesel engine the return is as much as thirty-seven per cent. Though in the use of oil for steam raising the consumer can afford to pay about twice as much for oil as he pays for coal, in view of the higher thermal efficiency of oil and other advantages attaching to its use, yet in the light of present knowledge it would be wrong to suggest that the supply can ever become so abundant as to give consumers in general a free choice in substituting oil for coal as a source of power. Sir Boverton Redwood concluded his address with a strong appeal for the economic and scientific exploitation of oilfields. Millions of pounds sterling have been thrown away in haphazard drilling operations, and valuable oilfields have been destroyed by reckless procedure. The petroleum industry presents unusual difficulties, and demands genius for its most successful conduct. It is gratifying to learn that various educational institutions, including the Royal School of Mines, are giving special attention to the training of students in the technology of petroleum.

GEOGRAPHY.

By A. Stevens, M.A., B.Sc.

THE IMPERIAL ANTARCTIC EXPEDITION.—Through the medium of the daily Press the public is already familiar with the outline of the plans which Sir Ernest

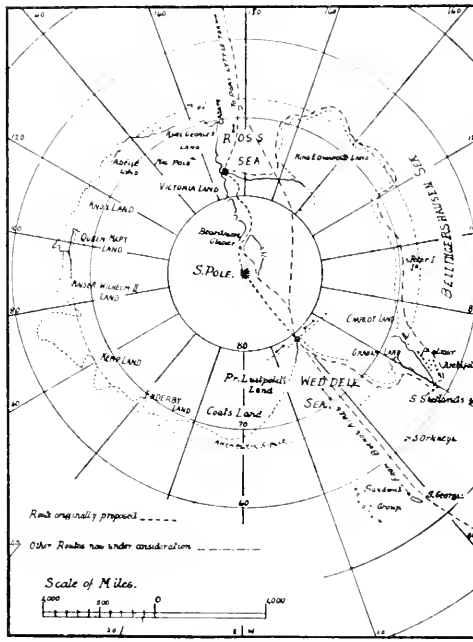


FIGURE 99.

Sketch map for showing the routes proposed for the Imperial Antarctic Expedition.

Shackleton has proposed for his new Imperial Antarctic Expedition. We print a map (see Figure 99) to illustrate the routes under consideration—that originally proposed and those others which have been suggested by eminent geographers, and which Sir Ernest will regard as alternatives.

The plans for the new expedition have been welcomed in the scientific world. While the main object of the leader is to accomplish a traverse of the Antarctic Continent, and thereby settle the question of the existence of a polar landmass, scientific interest centres also round two other points. The expedition will determine the extension of the range of mountains which crosses Victoria Land; in particular, whether it reaches the Pole, and whether there are mountains continuing this chain or independent of it on the Weddell Sea side. It has been suggested that the Andes have there a southward extension in Antarctica. The obtaining of definite information on the matter is of considerable interest and importance. The second point is the meteorology of Antarctica. Here again many deductions have been based on what is known of the more accessible parts of the globe and applied to polar regions. The conditions

obtaining there are, as it were, boundary conditions for the terrestrial system, and actual verification or correction of the assumptions made regarding them is of prime importance. The scientific staff will include at least four geologists, and personnel and equipment will be provided for valuable work on biology, oceanography, magnetic observation, and surveying. We hope that public liberality towards this expedition will not await the stimulus of misfortune, and if it does, that it will wait in vain. The greater the financial support, the greater and more valuable the work that can be undertaken.

THE INTERNATIONAL 1/1,000,000 MAP OF THE WORLD.—In the last four years some dozen sheets of this map have been prepared, and a recent congress met at Paris to consider the undertaking in the light of the experience so gained. The unanimity of the representatives of geography, to which is due the inception of the map, is one of the most pleasing features of their deliberations. Several modifications of the plans adopted in London in 1909 have been introduced. The uniform contour interval of one hundred metres was found to be inconvenient. Contours at two hundred metres, five hundred metres, and above that at intervals of five hundred metres will appear in all maps as continuous black lines, and contours at one hundred-metre intervals, where found practicable, as interrupted lines. The colours used to indicate the relief will still change at intervals of one thousand metres on the higher ground, but the browns will pass into carmine instead of magenta. Colouring will stop at the snow-line, and glaciers will be indicated in blue. China has undertaken the production of the maps of Chinese territory. A permanent office will be established in Great Britain for the purpose of issuing an annual report and circulating information and useful data. It is gratifying that the representatives of the various countries were sent duly accredited by their Governments, and that they will present the proposals of the Congress to these for formal ratification.

A NEW STREAM TYPE.—In an interesting article in a recent number of *The Journal of Geology* Mr. C. R. Keyes describes the action of wind-scour in modelling the complete topography of desert regions. The example cited is the northern Mexican tableland. This region underwent planation and uplifting before its climate became arid. Its topography cannot be the result of normal stream erosion on recently upraised orogenic blocks, for the profound faulting in the area took place in very ancient times. The dissection of the plateau is ascribed to the differential action of deflation on the weak and resistant beds which respectively form the main body of the upper and lower parts of the rock sequence in northern Mexico. The process has given the mountains an aspect characteristic of the early stages of stream erosion. The existence of a scanty rainfall is held to be actually due to the aridity of the region. As wind erosion under arid conditions imparted unevenness to the ground, it acted as a provoker of rain. The streams thus produced increased in size slowly as the relief of the ground became more marked, but they are doomed to reach a circumscribed maximum of size and efficiency, and have no ancient connection, like normal streams, with a primaeval drainage system.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

THE GEOLOGY OF SOUTH GEORGIA.—South Georgia is a remote island lying in Antarctic waters to the south of the Atlantic Ocean, about nine hundred miles south, eighty degrees west, of the Falkland Islands. It has recently been visited by Mr. David Ferguson under the auspices of Messrs. Chr. Salvesen & Co., of Leith, the well-known shipowners, who have a whaling station on the island. An account of the geology of the parts of the island visited by him is contributed by Mr. Ferguson to the February *Geological Magazine*, with an appendix on the petrology by the present writer, and a paper on the geological relations of South Georgia by Professor J. W. Gregory, F.R.S. South Georgia is a narrow elongated island, one hundred and ten miles long, with a greatest width of twenty-three miles. Its longitudinal axis is a mountain-range whose highest point, Mount Paget, rises eight thousand three hundred and eighty-three feet above sea-level. The central range is covered with permanent snow and ice, from which glaciers sweep down the main valleys to the sea. Geologically South Georgia appears to consist mainly of sedimentary rocks which are highly indurated, folded, and in places metamorphosed. These are mainly greywackes, slaty grits, mudstones, shales, and slates, passing into phyllitic grits and phyllites with increasing metamorphism. Interbedded with this series are sparse gritty limestones and more abundant tuffs. The latter are composed of mineral fragments and rock-chips of dominantly trachytic lava. They are in general remarkably fresh, but in some places have undergone sporadic scapolitisation. Mr. Ferguson divides the sedimentary succession in South Georgia into the Cumberland Bay Series, with Upper, Middle, and Lower Divisions, which unconformably overlie an older Cape George Series.

The geology of South Georgia is of special interest, since it promises to throw light on the geological history of the southern ocean to the south of the Atlantic, and on the tectonic relations of South America to West Antarctica. According to Suess, South Georgia is a part of a great loop-like continuation of the Andes, which, bending eastwards in Tierra del Fuego, continue thirty degrees to the east, through South Georgia, and then returns through the South Sandwich Islands and the South Orkneys to Graham Land. This loop may be considered homologous to that which forms the Antilles and unites North and South America.

Despite the new information, however, the evidence afforded by the rocks of South Georgia on this question remains indecisive. Certain fossils, unfortunately rare and often fragmentary, have been found in the Cumberland Bay Series. A *Posidonomya*, probably Cretaceous, was found by the Swedish Antarctic Expedition, and an ammonite, identified doubtfully as an *Acanthoceras* by Professor Pompeckj, was found by the German Antarctic Expedition of 1911, led by Lieutenant Filchner. A number of fossils were also found by Mr. Ferguson. Some of these are fucoidal; others may be much-crushed simple corals, resembling *Omphyma*. A few of radiolaria were found during the microscopic study of the rocks, and these have been identified by Dr. Hinde, who concludes that they are post-Palaeozoic and pre-Tertiary, and might come in between the Triassic and the Cretaceous. The evidence for the age of these rocks is therefore poor, and even contradictory. According to Professor Gregory, the palaeontological evidence suggests the Palaeozoic age of the Lower Division and the Mesozoic age of the Middle and Upper Divisions of the Cumberland Bay Series. The evidence of the igneous rocks of the island is no less ambiguous. The interstratified tuffs are not of Andean type; and although an "altvulcanischer" basaltic area and granitic and dioritic rocks (occurring as blocks in the moraines) have been described by Fr. Heim in the eastern part of the island, no definite evidence exists at the present time to correlate these rocks with the typical products of Andean igneous activity.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

UPPER AIR RESEARCH.—Mr. C. J. P. Cave in his Presidential Address at the Annual Meeting of the Royal Meteorological Society dealt with the subject of upper air research. He pointed out that research in the upper air may be by means of manned balloons with observer and instrument, or by self-registering instruments sent up in

kite, captive balloon, or free balloon. Kites were first used for this purpose by Dr. Wilson of Glasgow, 1749; and also in Arctic expeditions in 1832 and 1836. The box kite and the use of steel piano wire instead of cord enabled greater heights to be obtained, and both were adopted by Professor Rotch at the Blue Hill Observatory in 1895. The use of kites for meteorological investigations was not taken up in England until 1902, when Mr. Dines flew them from a steamer off the west coast of Scotland.

After referring to the use of balloons and the ascents made by Glaisher and others, Mr. Cave said that danger to life in high ascents caused MM. Hermite and Besançon to use a registering balloon in 1893; a free balloon carried a recording instrument, the recovery of the instrument being dependent on the balloon being found after its descent; a height of nine miles was reached in France and thirteen and a half miles in Germany soon after. Reference was made to the various types of instruments used in the research, and a description given of Mr. Dines's meteorograph, which is an extremely simple and light instrument. Rubber balloons are usually used, and as they ascend they tell of the winds above the surface. A special theodolite is used for observing the balloons.

Ingenious pieces of apparatus have been invented for upper air research. The latest is that by Dr. Assmann, which is intended to measure the temperature of the air over the sea, desert countries, or in Arctic or Antarctic regions when there is little chance of recovering the balloon. The balloon is watched through theodolites, and its height from minute to minute is calculated in the ordinary way. An arm attached to a thermometer completes an electric circuit at a predetermined temperature, say at freezing-point; the electric current explodes a firework hung below the balloon, and the observer sees a puff of smoke as soon as his balloon has entered a layer of air in which the temperature is at freezing-point. Other fireworks can be exploded in turn at predetermined temperatures, and it can be arranged that the fireworks connected with the various temperatures should show smoke of various colours, so that in the event of any particular firework accidentally failing to explode the colour of the next puff of smoke will show the temperature.

The International Commission for Scientific Aeronautics directs the studies of upper air research and special days are arranged for the international ascents of balloons and kites. Stations in various parts of the world now take part in the work.

The first great result of these researches has been the discovery that the atmosphere is divided into the troposphere, where the air is in constant movement, horizontal and vertical, and the stratosphere, where turbulent motion seems to cease. The stratosphere begins at about seven and a half miles in these latitudes. The method of investigation is new, but many other results are beginning to come to light, and it seems possible that the changes in the atmosphere to which our changes of weather are due, originate not at the surface of the Earth, as was formerly supposed, but in the layer of the atmosphere just below the stratosphere—or about seven miles up.

SIX RAINBOWS SEEN AT ONCE.—Mr. A. H. Waller in a communication to the *Quarterly Journal of the Royal Meteorological Society* states that on November 5th, 1913, a little previous to the Sun disappearing behind the mountains, he noticed at Umtali, Rhodesia, in the east, six brilliant rainbows extending for about one-quarter of the semicircle. Five were quite close together, and the sixth some little distance away.

METEOROLOGICAL CONFERENCE AT EDINBURGH.—The want of effective opportunity for discussing in conference the various aspects of the physical sciences in their application to the study of the phenomena of weather has long been felt, and it has been suggested that as there will be no meeting of the British Association in this country in 1914, it would be desirable to organise a Conference with that object. Upon the invitation of the Scottish Meteorological Society it is proposed that the Conference should take place in Edinburgh on Tuesday, September 8th and four following days. The mornings will be devoted to the discussion of scientific subjects connected with the study of the atmosphere. The afternoons will be available for demonstrations; lectures are to be arranged for two evenings and a reception for another. On the Saturday there will be excursions to some places of scientific interest.

The scope of the papers to be discussed will include the physical and observational aspects of Meteorology, Climatology, Oceanography, Limnology, Atmospheric Electricity, Terrestrial Magnetism, and Seismology. One of the objects of the Conference will be to bring together observers in these departments of science and those interested, from the theoretical point of view, in the discussion of the observations. To meet the necessary expense, the subscription for members of the Conference has been fixed at ten shillings; tickets of admission for ladies accompanying members will be issued at five shillings. All those who wish to join the Conference or who desire further information are requested to communicate with the Hon. Secretary of the Committee at the Meteorological Office, South Kensington, S.W.

MICROSCOPY.

By F.R.M.S.

THE TWIN MICROSCOPE.—Devices enabling one observer to view two objects conjointly have been adapted to the microscope in various forms. In all these arrangements prisms are employed to project the images formed of two objects into the field of view of one and the same eyepiece. The first two devices contrived for this purpose were employed for comparing the images formed by two independent microscopes.

An instrument of this kind, called a "Comparison Chamber," was first described by Inostranzeff in the "Neues Jahrbuch für Mineralogie," 1885, Vol. II, pages 94–96. It was designed for the microscopic examination of opaque minerals. The instrument took the place of the eyepieces and connected the two microscopes in bridge-fashion. A similar apparatus fitted with a different prism arrangement was at the instigation of Van Heurck made by C. Reichert, of Vienna, for the comparison of diatoms. He called this apparatus an *Oculaire Comparateur*, or "Comparison Eyepiece," and described it in his work "Le Microscope," page 101. In the two following arrangements, both of which serve the same purpose, the two microscopes form part of the same stand. A microscope of this kind, as devised by Ewell, will be found described and illustrated in the *Journal of the Royal Microscopical Society*, 1910, page 14. In Ewell's arrangement two microscopes are mounted side by side on one stand, so that there is only one foot, upright, stage, and focusing mechanism. The image formed by either objective is reflected into the eyepiece with which it is associated through the medium of a prism of rhomboid cross-section. Recently a very similar instrument, called a "Comparison Microscope," has been made by Seibert at the suggestion of Thorner, as described in *Mikrokosmos* (Vol. VI, 1911–12, page 123) and discussed by Wychgram in *Zeitschrift f. wiss. Mikroskopie*, XXIX, 3.

The new instrument as shown in Figure 100, which we will call a "Twin Microscope," differs in its optical arrangement considerably from those already referred to. Unlike these, the twin microscope is a binocular arrangement of two microscopes mounted on one stand, each being provided with its own complete optical equipment in the way of a mirror, illuminating apparatus, objective, and eyepiece. The stage is large enough to accommodate two preparations. Both body tubes are rigidly connected, and are displaced jointly by a rack and pinion coarse focusing adjustment, whilst the slow movement is by means of a fine screw fitted to either tube between the latter and the objective. The

distance between the eyepieces is adapted to that between the eyes after the plan adopted in the microscopes of the Greenough pattern, and, as in the latter arrangement, the images are rendered erect by the aid of Porro prisms. Both the eyepiece drums surmounting the tubes which contain the Porro prisms and oculars are movable, and by this means it is possible to displace the optical axes of this part parallel with one another and to set the interpupillary distance for each observer, as shown in Figure 101.

Both eyes of the observer receive by this means an impression of the two images, more or less superimposed, by virtue of a remarkable property of the eyes which causes an image seen by one eye to transmit itself to the other eye through the agency of a central nerve station. As a rule, these images are dissimilar. If they do not interfere with each other, and if the objects appearing in the field of view can be so arranged in position on the stage that one object may occupy a place in an unoccupied part of the field of view containing the other object, it will be easy to compare the two objects. Where, as is most often the case, the nature of the objects does not admit of this being accomplished, one half of either field of view should be cut off by means of the semicircular stops situated in the plane of the eyepiece diaphragm in such a manner that the other two semicircular halves may fuse into a complete circular field within which the two objects, separated by a scarcely perceptible line, can be seen side by side and compared. To view in rapid succession the two entire circular images the stops should be opened and closed alternately on the right and the left. This twin arrangement, by which the objects may be seen side by side in the same field or their entire fields viewed in rapid alternation, furnishes an excellent and convenient means of comparing healthy and pathologically modified tissues and adulterated and normal foodstuffs, and so on. It may be used with advantage for demonstrating side by side the distinctive characteristics of two allied objects. Also with this arrangement the same object may be shown under different magnifications, or it may be viewed by transmitted light or the method of dark-ground illumination, and by ordinary or polarised light. The instrument is also available for the examination of minerals illuminated by incident light, for which purpose Inostranzeff devised his "Comparison Chamber." Moreover, for examining and comparing two minerals by polarised light both optical equipments may be supplemented by the necessary adjuncts for mineralogical investigations. Also, the instrument is adapted for the colorimetric and spectroscopic examination of blood, which was the original purpose for which Ewell devised his arrangement. It is also probable that in many instances the instrument may be used for comparing the numbers of blood corpuscles contained in two preparations, thus dispensing with the necessity for a carefully conducted count. The instrument differs from others devised for similar purposes, in that it is available for stereoscopic observations. It can be used in this way with particular advantage where an observer is able to produce greatly reduced stereoscopic pictures of large objects, as the twin microscope provides an excellent means of viewing these in relief magnified to the natural size of the object. The Twin Microscope is made by Messrs. E. Leitz, of Wetzlar, and 18, Bloomsbury Square, London, W.C. C. Metz.

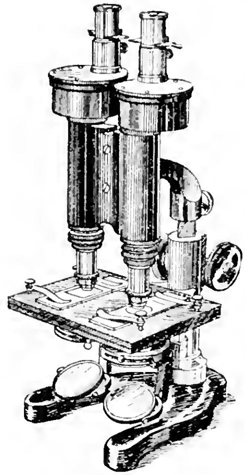


Figure 100.
The Twin Microscope.

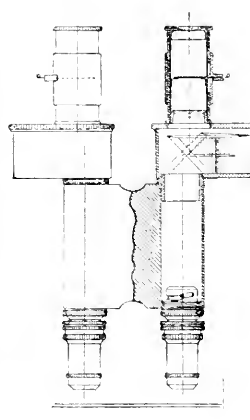


Figure 101.

THE QUEKETT MICROSCOPICAL CLUB.—At a meeting of the Quekett Microscopical Club, held on January 27th, Mr. S. C. Akehurst read a paper on "Some Observations concerning Substage Illumination." The paper described the several advantages to be obtained by the use of a reflecting condenser in resolving fine diatom structure, the Leitz concentric model being the one employed. A number of photomicrographs by Mr. T. A. O'Donohoe in illustration were thrown on the screen. Mr. T. A. O'Donohoe discussed "An Attempt to Resolve *Pinnularia nobilis*." This referred to the fine lines between the costae which a two-millimetre apochromat of N.A. 1·3 failed to resolve into dots when used with an immersion condenser and central cone, but on substituting the reflecting condenser referred to above a resolution was obtained of which a photomicrograph was exhibited.

PHOTOGRAPHY.

By Edgar Senior.

SODIUM THIOSULPHATE ("HYPO").—From the time when Sir John Herschel first described the solvent power of what were termed "the alkaline hyposulphites" upon chloride of silver, the substance employed by the photographer in fixing his negatives and prints has invariably gone by the name "hyposulphite of soda," in spite of the fact that the name is not correct from the constitution of the substance. It may, however, be considered that this is of little importance to the photographer, since the name has become by long-continued use so thoroughly established that there is very little chance of any confusion arising. However, the name "hyposulphite of soda" really signifies a sodium salt derived from a sulphur acid containing less oxygen than sulphurous acid, or less oxygen in the molecule than a sulphite; and in the case of a sodium compound such a substance would have the formula Na_2SO_2. So long as this salt remained unknown, however, no confusion could possibly arise, but when, owing to the work of, Professor Schutzenberger, this body came into existence, it became necessary to assign a name that should correctly express the constitution of the substance used by the photographer as a fixing agent. On this account chemists now call the "hypo" used by the photographer "sodium thiosulphate," a name which has reference to its composition, showing that it is derived from a sulphur acid (sulphuric) in which an atom of oxygen has been replaced by sulphur, the prefix "thio-" being derived from the Greek θεῖον sulphur; thus sodium sulphate having the constitution

$$SO_2 \begin{cases} ONa \\ ONa \end{cases} = Na_2SO_4$$

sodium thiosulphate becomes

$$SO_2 \begin{cases} SNa \\ ONa \end{cases} = Na_2S_2O_3.$$

This salt is therefore a derivative of thiosulphurous acid,

a body which, however, has not been obtained in the free state. Thiosulphates, like sulphites, are readily oxidised, but under certain conditions they yield oxygen to more powerful reducing agents, and thus themselves become oxidising agents. Sodium hypochlorite, ferric chloride, free chlorine, and so on, completely oxidise thiosulphates to sulphates, even in a cold solution; thus ferric chloride gives with sodium thiosulphate a violet-coloured solution at first, which, however, on standing is slowly decolorised, the ferric salt being reduced to ferrous, thus:

$$Na_2S_2O_3 + 4Fe_2Cl_6 + 5H_2O = 2NaHSO_4 + 8FeCl_2 + 8HCl.$$

Thiosulphate of soda, which is a white crystalline substance containing about forty per cent. of water of crystallisation, is chiefly of interest to photographers as a means by which the unaltered silver salts in their negatives and prints may be readily decomposed, an operation technically known as "fixing." And, although the thiosulphate is very readily soluble in water, recent researches of MM. Lumière and Seyewetz go to show that there is great difficulty in completely removing it from prints by simply washing. Experiments conducted by these investigators showed that when a solution of thiosulphate of soda has been used for fixing a certain number of prints, and consequently contains dissolved in it an appreciable quantity of soluble silver salts, any further prints treated in the same solution cannot be completely freed from all traces of "hypo," however prolonged a washing may be given to them, as in all cases it was found that prints so treated exhibited a brown stain when treated with a solution of silver nitrate used as a test for the presence of "hypo." As a possible explanation of the difficulty of entire removal of the fixing solution by washing in water MM. Lumière and Seyewetz think that probably the double thiosulphate of silver and sodium, which is formed during the time that the print is in the fixing bath, may undergo some change, with the result that thiosulphates are formed which are less soluble and incapable of removal by means of the combined action of water, aided by pressure exerted with a squeegee, as experiments carried out with P. O. P., bromide, gaslight, collodio-chloride, matt albumen, and prints toned in a combined toning and fixing bath all showed, even when the fixing bath had only been used for a very small number of prints, and these had been very thoroughly washed, that sufficient thiosulphate compounds still remained to produce the characteristic reaction with the silver nitrate test. It was found that of twenty prints toned in a combined toning and fixing bath, and afterwards washed for twenty-four hours, the whole of them still contained enough "hypo" to give a strong brown stain with silver nitrate. A similar number of prints treated in another portion of toning and fixing solution showed that in the first two prints only could the "hypo" be removed completely by washing, and from the third print onward silver nitrate produced stains which were more pronounced the more the bath had been used. As a means to prevent this, and ensure the complete removal of "hypo," MM. Lumière and Seyewetz made use of two fixing baths, the second following after sufficient washing to remove the greater part of the "hypo" of the first. They thus recommend that prints shall be placed in the usual fixing bath, and allowed to remain for five minutes, after which they are to be washed for one hour, and that at the end of every fifteen minutes the prints shall be drained and as much of the solution as possible pressed out with a squeegee, and the washing again continued. At the expiration of one hour the prints are to be placed in a second fixing bath of the following strength:—

"Hypo"	...	...	...	4 ounces
Water	...	...	...	20 ,,

and allowed to remain in this for five minutes, after which they should be again washed for a period of from one to one and a quarter hours, when a drop of the silver nitrate test solution applied to a print should not produce any appreciable colour after the lapse of two or three minutes. When a considerable number of prints have been fixed in the second bath it may be taken in use as the first, and a fresh one made up in its place. The idea of a second fixing bath is not a new one entirely, as the desirability of such a procedure was pointed out by Sir William Abney many years ago in order to ensure perfect fixation of prints.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

THE TUBE OF THE PISTOL CRAB.—R. P. Cowles describes the way in which *Alpheus pachychirus* of the Philippines makes its tube of matted alga-threads. The tubes are often twenty-five to thirty centimetres long and two centimetres in diameter, and one end is fixed to the rock. A male crab placed on a piece of matted alga turned itself on its back, and, using the slender chelate limbs immediately behind the forceps, drew the sides of a furrow together and sewed them by a simple stitching. Threads of alga were drawn from each side into the opposite side. On another occasion a tube was torn into shreds and given to a pair of crabs, which made a coherent tube by next morning. Filaments were entangled on the edges of a sheltering piece of rock and then drawn together. "When the alpheus found a hole in the rapidly forming tube the slender legs came through, caught hold of the filaments of the alga, and manipulated them in much the same manner as a man might the thread with which he darns a hole in his sock; that is, by drawing the edges of the hole together and fastening them."

LICE ON SEALS.—One would not expect animals so much in the water as seals to be infested with lice, and yet they have their peculiar pests. Thus Mr. William Evans reports *Echinophthirius phocae* (Lucas) from the common seal (*Phoca vitulina*) shot at the Isle of May in the Firth of Forth. The seal was so terribly infested that forty-three lice were taken off one square inch, and every hair had one or more eggs attached to it. Mr. Evans notes that the thick coating of stiff hairs on the louse no doubt serves to retain a supply of air for respiration while its host is under water.

INHERITANCE IN SHORT-TAILED AND TAILLESS DOGS.—Philippe de Vilmorin has made a number of crosses between dogs with normal tails and dogs with short tails or none. Out of one hundred puppies fifty-two were normal and forty-eight had short tails or none. From two normal parents of pure race only long-tailed puppies are got. Short-tailed or tailless parents give a progeny with a certain proportion of long-tailed forms. It appears, therefore, that the long-tailed forms are homozygous and recessive, and that the short-tailed or tailless types are heterozygous. It need hardly be said that cases of artificial curtailment have to be carefully excluded. There is no transmission of that mutilation in any degree.

ENDURANCE AND LONGEVITY OF FLEAS.—Socrates asked how far a flea could jump, but it is even more important to know how long it can live. It is important because fleas are bearers and disseminators of various parasites (among Bacteria, Protozoa, and even Helminths); thus the rat-flea of India (*Xenopsylla cheopsis*) is the bearer of the plague microbe. The British rat-flea (*Ceratophyllus fasciatus*) usually passes through its developmental cycle in two to three weeks; in ten days in warm, damp weather. Gautier and Raybaud kept one alive on human blood for ninety days. Another lived for forty-one days in an ice-chamber without feeding. Dr. William Nicoll finds that a rat-flea can live on an average about a week apart from its host. The period of survival is longer at low temperature and in the light; it is shortened by excess of dryness or by excess of moisture. Very important, however, is the discovery that the larvae and pupae may survive in infected material (grain, sawdust, brushings, and so on) for so long as a year.

TWO KINDS OF MALES IN A SPECIES OF SPIDER.—Dimorphic males are well known in some insects and crustaceans, but there are few instances among spiders.

Dr. T. S. Painter has recently studied the case of a North American species, *Maevia vittata*, where two kinds of males occur, "the tufted" and "the grey." The Peckhams mention another Jumping Spider, *Zygoballus bettini*, in which there are large and small males. The tufted males of *Maevia vittata* differ from the greys (which are like the females) in the colour of the legs, in the colour of the palps, and in the possession of three tufts of hairs on the cephalothorax. Now it is exceedingly interesting to find that the two forms differ also in the method of their "love-dance" before the females, and in a minute cytological detail. It was found that the nuclei of the cells of the greys carried a pair of chromosomes which the tufted males lacked. The females showed no preference for either type. We have probably to do with a mutation on which selection has not operated. The numbers seem to be approximately equal.

THE LIVING OKAPI.—M. Wilmet has made some observations on this rare inhabitant of the mountainous forests of the Congo. He kept one alive for a month at Wamba. It is an extremely clean animal, and licks itself like a cat. It is very timid and dislikes the light of day. It travels and feeds by night. The leaves of young branches form its chief food. A pair and a young one may be seen together, but never more. The minute horns are confined to the males. M. Wilmet's captive was a young one, which he fed chiefly on goat's milk. It became tame and would come when called. Unluckily, however, on the twenty-fourth day it went off its food, and died three days afterwards.

DEVELOPMENT OF A RABBIT'S EGG CONTINUED OUTSIDE THE MOTHER.—Professor A. Brachet has made the very important experiment of removing the developing egg of the rabbit on the sixth or seventh day, while it is still a blastodermic vesicle, with no differentiation beyond the establishment of the germinal layers, and placing it with many precautions in a clot of plasm prepared from the rabbit's blood. The germ not only survived for twenty-four to forty-eight hours in this artificial medium, but exhibited progressive development. It differentiated normally into an embryonic portion, the beginning of the placenta, and a "papilliferous zone." The daring experiment shows that the inherited nature embodied in the organisation of the germ can express itself for a time in conditions of nurture very different from the normal.

REMARKABLE CYPRINODONT FISH.—C. Tate Regan describes a minute fish, about an inch long, from Johore, in which the males are distinguished by the possession of a relatively large and very complex intromittent, or inseminating, organ. It is quite unlike any other organ of the kind, and there are several associated peculiarities, such as the length of the male duct or vas deferens, and the wide separation of the genital and urinary apertures. It is remarkable to see such a relatively large amount of complex structure specialised in a tiny fish for reproductive purposes. The name *Phallostethus dunckeri* is proposed for the new type.

SOLAR DISTURBANCES DURING JANUARY, 1914.

By FRANK C. DENNETT.

Conditions were very poor for making solar observations during January, the Sun not being seen at either station on nine days (4th, 8th, 9th, 13th, 15th, 19th to 21st, and 30th). On seven days (14th, 17th, 24th, 25th, 27th, 28th, and 31st) the disc appeared free from disturbance. Dark spots were observed on five (1st to 3rd, 5th and 7th) and faculae on the remaining ten. The longitude of the central meridian at noon on January 1st was 228° 38′.

Nos. 20 and 21 of December, remaining visible until January 3rd and 2nd respectively, both reappear on our present chart with the faculic surroundings of the former, which remained visible until the 6th.

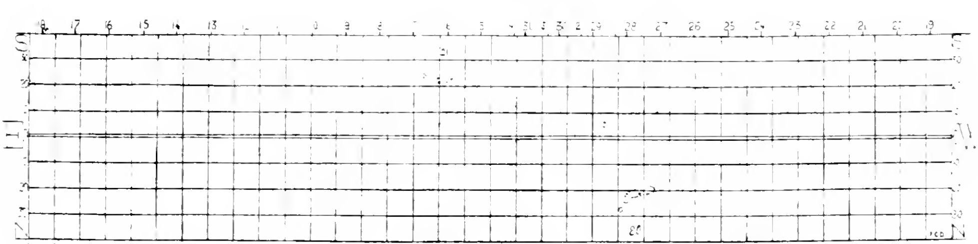
On the 5th a penumbraless spot was seen, but not measured, in high northern latitude, about nine days on the disc, and therefore not far from longitude 201°. At the same time a pore was seen in medium south latitude some six days on the disc—and so near longitude 162°—which makes it probable that it was in some way connected with the disturbance No. 21.

On the 7th, in fairly high northern latitude, about nine days on the disc, which would be near longitude 175°, there were two small penumbraless spots.

A small facula on January 2nd, seen at longitude 153°, S. latitude 24°, a little east of No. 21. The fine group seen on the 5th and 6th near the north-west limb marked the position of No. 20. On the 7th a facula was observed near longitude 224°, S. latitude 6°, near the western limb. Also near the western limb on the 10th, and so about in longitude 200°. On the 11th and 12th a fine faculic area was closing up to the south-west limb; clouds and snow prevented measurements, but it was doubtless the remains of No. 21. On the 16th a faculic disturbance near the south-west limb, probably between longitudes 100° and 110°. On the 18th a faculic disturbance some two days within the eastern limb, near longitude 300°. On the 22nd faculae were recorded within the north-eastern and south-eastern limbs; the former in longitude 237°, was probably a remnant of No. 20. A bright knot, amongst fainter ones, seen on the 23rd at longitude 231°, N. latitude 27°, and also a small one in south polar regions. On the 26th a small faculae seen in the south polar region, and also near the south-east limb. On the 29th a small facula in the south-east at 154°, 23° S.

The note and chart is prepared from the observations of Messrs. John McHarg, C. P. Frooms, J. C. Simpson, and the writer.

DAY OF JANUARY, 1914.



NOTICES.

THE PEOPLE'S BOOKS.—Among the forthcoming People's Books is one on "Wild Flowers," by Mr. MacGregor Skene, B.Sc., which will be very fully illustrated.

THE INCURSION OF WAX WINGS.—*British Birds* for March contains several pages of notes on "The Incursion of Wax Wings" into the British Islands during the past winter, which are supplementary to those already published in the February number.

MESSRS. A. & C. BLACK'S SPRING LIST OF BOOKS.—This catalogue contains several works dealing with medical science, and some natural history books, including "Common British Beetles," by the Rev. Charles A. Hall, which is the twelfth in the "Peeps at Nature" series.

THE JOURNAL OF MICROLOGY.—Our readers will be interested in hearing that the Postal Microscopical Club is now issuing a printed magazine called *The Journal of Micrology and Natural History Mirror.*—The publishing offices are 22, Carnarvon Road, Reading, and the subscription is 3/6 a year, including postage.

NEW LANTERN SLIDES.—Messrs. Flatters & Garnett's supplementary catalogue of lantern slides contains those which have been added to their list during the year 1913. Among them are a large number of photographs of British wild flowers and a series dealing with commercial geography produced by Dr. N. Wilmore.

THE FARADAY HOUSE JOURNAL.—The issue of *The Faraday House Journal* for Lent term has reached us. It is edited by Mr. E. A. Nash, the Secretary of Faraday House, and, besides containing much information of particular value to the students of that Institution, it includes interesting notes and articles on engineering subjects, particularly with regard to electricity.

BOOKS ON GARDENING.—Considerably more than a thousand titles are included in the "Gardening Catalogue" which Messrs. John Wheldon & Company have sent to us. We notice that Pennant's copy of Miller's "Gardener's Dictionary" is included under the heading "Early Gardening and Husbandry," and that inserted in it are some interesting lists of fruit trees, heaths, and seeds.

BIBLIOGRAPHY OF ASTRONOMICAL STUDIES.—The Royal Observatory of Belgium has issued an appeal to astronomers to send in details with regard to the personnel, instruments, research work, and publications of the various observatories throughout the world, in order to make as complete as possible a second edition of "Les Observatoires Astronomiques et les Astronomes."

BRITISH-MADE X-RAY TUBES.—We are pleased to call attention to Mr. C. H. F. Muller's catalogue of X-ray tubes manufactured in England, and to mention the coloured plates, in all cases taken from actual photographs of Muller Tubes, which should be of much use to workers when judging of their appearance. The catalogue contains much information as to the selection and manipulation of the tubes.

LECTURES AT THE HORNIMAN MUSEUM.—The following lectures will be given free on Saturday afternoons in the new Lecture Hall in the Horniman Museum, Forest Hill, at 3.30 p.m.: March 7th, "Parachuting and Flying Animals," Mr. H. N. Milligan, F.Z.S. (Zoölogist at the Museum); March 14th, "Bygones," Mr. Edward Lovett; March 21st, "Makers of Soil," Dr. E. Marion Delf; March 28th, "Magic and Fetishism in West Africa," Mr. A. R. Wright.

THE CAMBRIDGE BRITISH FLORA.—The publication of the new and important "British Flora," written by Dr. C. E. Moss with the help of a number of specialists, will be begun on March 18th with Volume II (Dicotyledonous families, such as poplars, willows, oaks, and elms, as well as docks, goosefoots and glassworts). The work will be completed in about ten volumes; the price was raised on February 16th from £2 5s. to £2 10s. each. Subscribers to the whole series will now pay £2 5s. per volume instead of £2.

INTERNATIONAL CONGRESS OF TROPICAL AGRICULTURE.—We would remind our readers that the third International Congress of Tropical Agriculture will be held on Tuesday, June 23rd, to Tuesday, June 30th, 1914, at the Imperial Institute, South Kensington. The principal object of the Congress is the discussion of ways and means of improving agriculture in the Tropics and thereby increasing the production of the numerous foodstuffs and industrial raw materials derived from tropical countries—matters which are of vital interest to the trade and industries of the United Kingdom.

PRESS PHOTOGRAPHY.—A long-felt want is about to be satisfied by Messrs. A. & C. Black with a complete practical manual of Press photography, entitled "Photographs for the Papers: How to Take and Place them," by John Everard. The book is intended alike for the beginner in Press photography, the photographer wishing to take up the journalistic side of his profession, the journalist anxious to add photography to his literary work, and the amateur desirous of making his hobby pay. Considerable space is devoted to the daily, weekly, and monthly publications, and the different kinds of photographs suited to each.

THE BECK BINOCULAR MICROSCOPE.—We have received from Messrs. R. & J. Beck a booklet describing their new binocular microscope, which, it is claimed, has resolving power equal to that of a monocular, into which it can be converted by a touch. The cone of light entering the objective is not divided in the ordinary way, but allowed to impinge upon a silvered surface, which allows some of it to pass through to one ocular and the rest to be reflected to the other. As the transparency and reflecting power of the surface can be regulated, it is possible to ensure that each eye gets the same illumination, whereas in the old type of binocular the light that reaches one eye is of only about one-sixth the intensity of that which goes to the other. Any objectives or eyepieces may be used, the body tube is short, stereoscopic effects can be obtained, and the danger of eye-strain is removed.

SWEDENBORG'S PHILOSOPHY.—On Friday, February 27th, a lecture on "The Body and the Soul in Swedenborg's Philosophy" was delivered by Monsieur L. de Beaumont-Klein, D.Sc., under the auspices of the Swedenborg Society. The chair was occupied by the Honorary President, Sir W. F. Barrett, F.R.S.

The lecturer gave a detailed account of Swedenborg's physiological and psychological doctrines in relation both to the views of his contemporaries and the latest products of modern thought. Swedenborg, he pointed out, held very advanced views on the functions of the spinal cord and brain. Reference was also made to spontaneous generation, which the lecturer said might be considered as a biological fact, though not necessarily in opposition to the principle that Life is the one source of life.

Proceeding to psychology the lecturer advanced to Swedenborg's fundamental conclusion that the human soul is a spiritual substance and form intended to receive life from God, and he pointed out that Swedenborg's doctrine of spiritual influx supplied that ultimate continuity which modern philosophy was seeking. Amongst other highly interesting points dealt with were Swedenborg's analysis of the soul into understanding and will, and the unequal grades of development of which these two elements are capable; also Swedenborg's distinction between two memories in man—a spiritual and a natural—which seems so much akin to Bergson's distinction between what he terms pure memory and perception.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

APRIL, 1914.

ASTRONOMY AND MODERN NOVELISTS.

By PHILIP H. LING, M.Sc.

JULES VERNE.

Of all the sciences astronomy is that which appeals most to the imagination, and it might have been expected that it would accordingly be much favoured by poets and novelists. This is not the case. Comparatively few authors have cared to introduce astronomical ideas into their works, and this for two very sufficient reasons, for the general public takes very little interest in the subject, and the novelist who bases his plot upon it runs some risk of becoming unintelligible to the majority of his readers; and, in the second place, astronomy dealing largely with the Universe outside the Earth, it is a matter of considerable difficulty to use it in connection with merely human characters.

But, whereas the novelist may, with some trouble, introduce the external Universe into his work, it seems to have been overlooked that he may possibly by that means be making a serious contribution to astronomical science. His work is the work of the imagination, and it is conceivable that he may succeed in penetrating further into the secrets of the Universe than the more orthodox man of science. At all events, his suggestions may be entitled to serious consideration.

Of the few who have attempted to write what we may call the astronomical novel perhaps the most famous is the late M. Jules Verne, an author whose works were the delight of generations of boys, and who has, with some injustice, been rather slighted by their elders. He was not a man of science, which is equivalent to saying that his statements are not invariably marked with scientific clearness. But as has been often pointed out, he succeeded, in some cases, in forecasting advances in various branches of science with an accuracy which is absolutely startling. The submarine vessel in "Vingt Mille Lieues sous les Mers" is a case in point; and there is another remarkable instance mentioned in the present paper.

M. Verne wrote five books more or less connected with astronomy. The first two, "De la Terre à la Lune" and "Autour de la Lune," form practically one work, published in 1865. We are here introduced to a group of Americans of a most enterprising type. The Gun Club, of Baltimore, having lost its occupation at the close of the Civil War, determines to fire a projectile to the Moon. The cannon is a cylindrical hole in the ground, suitably lined, and the projectile is hollow, so as to carry passengers. Three men take their places in it, and the gun is fired by means of a large charge of gun-cotton powerful enough to send it out of reach of the Earth's attraction. The projectile, however, misses its mark, and, after rotating round the Moon, falls back into the Pacific Ocean.

The curve described by M. Verne's bullet raises some very interesting questions. It begins and ends on the Earth, and is therefore what is now called a "closed orbit of ejection." A particle projected from the Earth, and subject only to its attraction, would, of course, describe such an orbit; but under the simultaneous influence of the Earth and the

Moon the existence of such orbits is by no means obvious. They appear to have been first mentioned by Burrau,* who examined some particular cases. Sir G. H. Darwin† also pointed out certain examples. It is only quite recently, however, that the general theory has been discussed by Professor F. R. Moulton,‡ who has proved the existence of such orbits in the restricted problem of three bodies, and found the initial conditions necessary. M. Verne seems to have forestalled these investigators by a considerable interval of time, and it is only fair that some credit should be assigned to him. His excursions into the theory are unfortunately not very clear. He says there was a miscalculation in the case of the initial velocity of the projectile, which rendered it too large: but the cause of the failure to strike the Moon was a close approach to a mysterious asteroid—of which more presently—so that his orbit of ejection is really a case of the problem of four bodies. So far as can be made out, it appears to be a figure-of-eight orbit, with the Earth at the end of one loop and the Moon just inside the other. Whether such an orbit is actually possible has not yet, I believe, been ascertained.

Many years later M. Verne wrote a sequel, entitled "Sans dessus dessous," which appeared in the *Boy's Own Paper* (1890) as "Barbicane and Co.," and was reprinted as "The Purchase of the North Pole." The same characters, wishing to reach some hypothetical coalfields at the North Pole, conceive the idea of displacing the axis of the Earth by means of a violent shock administered by firing off a gigantic cannon. The mathematician employed, however, makes a mistake in the calculations, and the experiment not only fails, but is proved to be impossible.

An earlier work was "Hector Servadac" (1877), one of the author's wildest ventures. A comet collides with the Earth, and carries off a part of it, together with those persons who happen to be on the spot at the time. It is unlike other comets in being a compact solid body, which consists of an alloy of gold and tellurium; and its periodic time is exactly two years, so that a second collision occurs and deposits the travellers neatly back on the Earth. It will be seen that the story is by no means well constructed; indeed, some critics have marked it as the beginning of decadence in M. Verne's work. But it contains a considerable amount of information, and is never wanting in interest.

The fifth of the astronomical novels is "La Chasse au Météore," one of the author's last books. The central idea is that of a large meteor describing a closed curve round the Earth. It consists of pure gold, thus, to some extent, resembling Hector Servadac's comet Gallia; and an ingenious Frenchman, by means of a mysterious machine which he has invented, succeeds in bringing it down to Earth.

The suggestion of a second satellite to the Earth is one of which M. Verne seems very fond. Twice in his books—once in "Les Cinq Cents Millions de la Bégum," and once in "Sans dessus dessous"—terrestrial projectiles assume permanent orbits round the Earth; and twice—once in "Autour de la Lune" and once in "La Chasse au Météore"—the question of an actual satellite arises. In "Autour de la Lune" the idea is attributed to "a French astronomer, M. Petit," who determined the existence of the body, and its period, from certain perturbations. If this is a genuine reference, the suggestion is one which has now been forgotten. The existence of such a satellite is not, of course, impossible, although the method of deducing it from the unexplained motion of the Moon is entirely out of the question.

M. Verne's contributions to astronomy appear, then, to be: (i) A suggestion of the existence of closed orbits of ejection; (ii) a method of approaching the Moon by means of a projectile; (iii) the idea of a second satellite to the Earth. For the last he does not claim the credit, and there is no actual evidence in its support. But the projectile method, unpractical as it looks, is of much interest. If the orbit mentioned exists and is stable, and if the initial velocity could be adjusted so as to secure exact motion in this curve, then there would be little risk of any harm coming to the projectile. The chief danger would arise from heat, due to friction with our own atmosphere, and from the final fall on the Earth. If, finally—"there is much virtue in 'if'"—the means of attaining a sufficiently high velocity were known, the problem would come within the range of the possible. It is to be supposed that it will sooner or later present itself to humanity, if only as a result of over-population. Meanwhile, speculative as it is, it need not be dismissed as devoid of interest.

* "Recherches numériques concernant des solutions périodiques d'un cas spécial du probléme des trois corps." *Astronomische Nachrichten*, CXXXV, CXXXVI (1894).

† "On Certain Families of Periodic Orbits," *Monthly Notices, Roy. Astro. Soc.*, LXX (Dec. 1909).

‡ "Closed Orbits of Ejection and Related Periodic Orbits," *Proc. Lond. Math. Soc.*, XI (June, 1912).

STONYHURST COLLEGE OBSERVATORY.

We have received the report of this busy observatory for 1913 from its Director, the Rev. Walter Sidgreaves, S.J., F.R.A.S. Meteorological and magnetical records loom largely in its work. We are told that the past year has been "remarkably mild and cloudy," with "no excessive heat and no great cold." On sixteen days the shade temperature reached, or exceeded, 70°, but once only, on August 3rd, did it reach 76°. The lowest record of temperature was made on December 31st, when the thermometer marked 21°. The excessive cloudiness of the year was shown by the Stokes Sunshine Recorder, registering three hundred hours less than the average of the past thirty-three years. The rainfall of the first three months was 6·5 inches above the average, but in the four from July to October there was a deficit of 10·5 inches, with the result that the total fall for the year was five inches short of the mean record. The greatest fall on any day in April during sixty-six years occurred on the 26th, when 1·180 inches were recorded. The total length of air crossing the Observatory during the year was one thousand two hundred and thirty-two miles below the average of eighty-six thousand five hundred and eighty-five miles. During July only four thousand five hundred and seventy-seven miles were registered, as against eight thousand two hundred and eighty-eight miles in 1877—both years holding a record for July. Last November holds the record for the past sixty-six years for the number of days—no fewer than twenty-eight—on which rain fell to the amount of ·005 inch or more.

The magnetic record on one hundred and thirty days was *calm*; on two hundred and six there was a very *small* amount of disturbance; on twenty-three it is marked *moderate*; but only once, on April 9th, was the disturbance sufficient to be marked *great*, and none with *very great*. No records are given for five dates.

The Sun was observed on two hundred days, on twenty-five of which spots and faculae were drawn, and on nineteen only faculae. This means that on 87·5 % of the observing days there were no dark spots. "The mean disc area of the spots (in units of $\frac{1}{5000}$th of the visible surface) appears at 0·04; and the mean daily range of magnetic Declination (in minutes of arc) at 9′·7."

These compared with the means of the past five years are:—

Year ...	1908	1909	1910	1911	1912	1913
Spot area ...	4°·6	3°·8	1°·8	0°·33	0°·22	0°·04
Declination range	14°·1	13°·5	14°·5	12°·6	8°·1	9°·7

This is the lowest mean disc area observed since the tabulations were commenced in 1898. The cloudy weather has militated against making solar or stellar spectrographs. The Observatory is now furnished with a wireless equipment, as well as with a seismological pendulum.

Frank C. Dennett.

SOLAR DISTURBANCES DURING FEBRUARY, 1914.

By FRANK C. DENNETT.

The weather during February was far from favourable for the telescopist, but it was found possible to observe the Sun every day with the exception of the 19th. Spots were seen on eight days (2nd to 7th, 18th, and 28th), faculae only on six (1st, 11th, 14th, 23rd, 24th, and 27th, whilst on the remaining twelve days the disc appeared free from disturbance. The longitude of the central meridian at noon on February 1st was 180° 27′.

No. 1.—First seen a little past the central meridian on February 2nd. The western spot or leader was largest, whilst behind it, and slightly more to the south, was a second spotlet with some pores on the eastern side; during the day its appearance altered somewhat. Slight alterations took place each day. On the 5th the leader contained two umbrae, and two pores preceded it. On the 6th and morning of the 7th the two larger components were still visible imbedded in faculae, but later, although the faculic disturbance was visible, the spots were gone. When the slit of the spectroscope was placed across the group on the 3rd, 4th, and 5th the C-line showed small but well-marked disturbances, being displaced both ways slightly, and containing small reversals and dark hydrogen flocculi, whilst on the 5th the dark D_3 line of helium was visible. The leader was over five thousand miles in diameter, and the maximum length attained was fifty-six thousand miles.

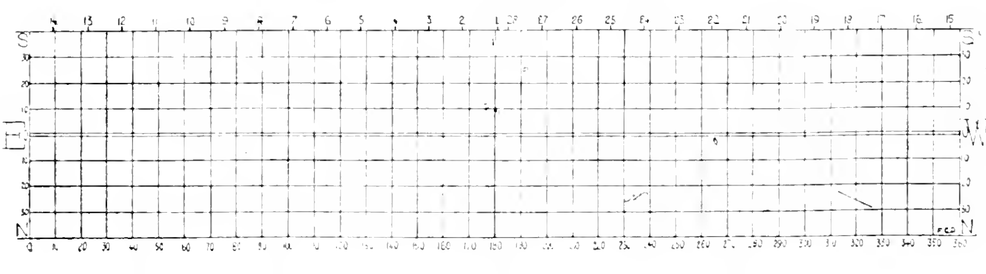
On the 18th there was one tiny black pore in the northern hemisphere. On the chart a line will be seen joining longitude 313°, latitude 23°, and 326°·5, 29°. The pore must have been upon that line, but clouds effectually intervened and prevented the completion of the requisite measures.

On the 28th there were one or two minute pores, too small for exact measurement of position, in the south-eastern quadrant.

Faculic disturbances were visible in the northern hemisphere on February 1st, between longitudes 230° and 239°. There was a faculic area on the 11th in the south-eastern quadrant. A small facula on the 14th was very near to the South Pole. On the 23rd, at about longitude 191°, S. latitude 26°, there was a faculic knot, and also some within the eastern limb on the 24th. Some small bright spots were nearing the western limb on the 27th and 28th, situated about longitude 265°, N. latitude 1° to 3°.

Our chart is constructed from the combined observations of Messrs. J. McHarg, E. E. Peacock, J. C. Simpson, C. Frooms, and the writer.

DAY OF FEBRUARY, 1914.



SPORE DISPERSAL IN THE LARGER FUNGI.

By SOMERVILLE HASTINGS, M.S., F.R.C.S.

(*With illustrations from photographs by the writer.*)

(*Continued from page* 103).

It is in those genera which assume the umbrella or shelf-like form that the best adaptations for the increase of spore-bearing surface are seen; and in these the sporogenous tissue is in all cases directed downward. In *Hydnum* (see Figures 95 and 102) we find the increase of surface by means of spines. *Hydnum erinaceum* is a large and beautiful form which grows from the interior of hollow trees. In the toadstools proper, the most successful of the larger fungi, the increase of surface is by means of folds or gills. In some forms, such as *Cantarellus* (see Figure 103), these folds are shallow and branched; but in most they take the form of thin plates closely packed together. In some of these, e.g., *Russula nigricans*, practically all the gills are of the same length, so that toward the margin large spaces exist between them. In this way an increase of surface area by six or seven times is obtained. But in most toadstools (see Figure 106) gills of various lengths are seen, and all the available space is filled. In the mushroom (*Psalliota campestris*), for example, an increase of area by twenty times is thus obtained, and in this fungus the least space between any two gills has been shown to be 0·2 millimetre, or double the distance that the spores are shot out horizontally before falling downward. This minimal distance of separation may be thought to indicate an unnecessary degree of caution on the part of Nature, as a little more than half this distance would do as well. But it has to be remembered that sometimes the stalk of a toadstool is displaced so that its cap is no longer horizontal; and though in such cases, as will be shown later (page 127), the gills usually at once respond, and again take up a vertical position, nevertheless the distance between any two will be of necessity decreased. In *Boletus* and *Polyporus* (see Figures 104 and 107, and 76 and 78) the gills of the toadstool are replaced by tubes, and in *Polyporus squamosus* (see Figure 76) an increase of eleven or twelve times the spore-bearing surface is by this means obtained. The genus *Fomes* (see Figure 105), which grows on trees, closely resembles *Polyporus*, except that its fruit (for the fungus plant is within the tree) is of firmer and more woody consistence, and lasts from year to year, producing a fresh growth of tubes annually. In this way very long tubes are formed, and the increase of spore-bearing surface for a specimen which had grown for twenty-five years was found to be no less than nine hundred and forty-two. But with long, fine tubes an absolutely vertical position is essential, else the spores in falling would strike and adhere to the sides. This is attained by the firm woody form and the broad base of attachment to the supporting tree.

The small size of the spaces between the gills of most toadstools (Agarics), or within the tubes of Polypori and Boleti, makes it essential that both should be maintained in an absolutely vertical position. Otherwise many of the spores, in falling vertically, would strike and adhere to the side walls, and become of no further use for purposes of reproduction. In the mushroom, for example, a tilt of anything beyond 2° 30′ will prevent some of the spores from falling free of the gills; and, although some of the gills will not be affected at all by a tilt of even 45° or more (see Figure 109), half the spores from others will be lost by a tilt of even 5°, and four-fifths by a tilt of 9° 30′. For this reason toadstools are, as a rule, very rigid, being hardly at all affected by wind, and are in consequence among the easiest of living objects to photograph. This rigidity is attained by a stalk, which is firmly implanted in the ground, and is either solid, hollow, or provided with an external fibrous layer. In most cases (see Figure 110) the cap is firmly attached to the stem, and no doubt the value to the plant of the firm fleshy tissue of which both are often composed is more for the maintenance of rigidity than for the nourishment of parasites that are liable to impair this (see page 101). In *Coprinus comatus* (see Figure 110) the attachment of the cap to the stem is less firm; but here, owing to the bell-like shape of the cap, its centre of gravity is well below the point of attachment of the stalk, and the result is that, even if the stem be tilted through several degrees, the vertical position of the cap is maintained. In the Parasol toadstool (*Lepiota procera*) (see Figure 108) the point of union between stem and cap is also high, but the attachment is much firmer.

As will be seen from the above, it is of the utmost importance to the toadstool that the cap should be kept absolutely horizontal and the gills vertical; and if anything should interfere with this position the toadstool, if immature, at once makes an attempt to rectify it by curvature of the stalk. We must all have noted the curved stems of toad-

FIGURE 1[illegible]. *Hydnum erinaceum* [illegible] the interior of hollow trees.

FIGURE [illegible]. *Fomes fomentarius.* A fungus that [illegible] from year to year. It [illegible] destructive parasite to forest trees.

FIGURE 1[illegible]. *Cantharellus* [illegible] depressions between the [illegible]

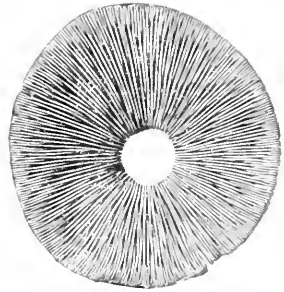


FIGURE [illegible]. Under surface of *Lactarius* [illegible] showing all the available space that [illegible] in the gills [illegible]

FIGURE 164. *Boletus* [illegible]. A toadstool with vertical tubes on the lower surface of the cap.

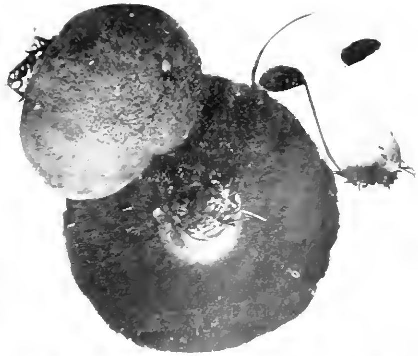


FIGURE [illegible]. *Boletus* [illegible] of cap and [illegible] in section.

FIGURE 110. The Parasol Mushroom (*Lepiota procera*).

FIGURE 111. A not quite mature specimen of *Amanita mappa* which had lain on a flat surface for 16 hours. The curving of the stem to return the cap to a horizontal position is seen.

FIGURE 109. A specimen of *Tricholoma rutilans* which had been standing on its side for 18 hours.

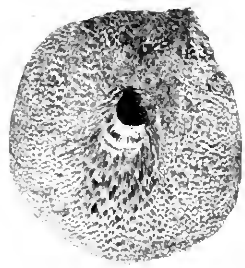


FIGURE 112. A specimen of *Boletus chrysenteron*, growing out from the side of a bank, showing how the tubes have grown downward.

FIGURE 108. *Coprinus comatus* and *Lactarius fragilis* in section to show the [illegible] caps.

FIGURE 113. A curious growth of a woody fungus found within the interior of a hollow tree.

stools growing from the side of a bank, and, experimentally, mushrooms have been made to bend through nearly a right angle by turning, through this angle, the substratum on which they grow. It must be rare, indeed, for a greater curvature than this to be required in a field or pasture. But the small Coprini, which grow on dung, can be induced to curve through a much greater angle, and the response to gravity is so rapid that the commencement of the curve has been observed within a minute and a half of the change in position of the material on which they grow. In Figure 111 is shown a not quite mature specimen of *Amanita mappa*, which had been pulled up and laid on a flat surface some sixteen hours before the photograph was taken. The bend in the upper part of the stem is well seen in it. But not only does the immature toadstool reäct to gravity by curvature of its stem; the mature fructification also responds by movements of the gills. Figure 109 is a specimen of *Tricholoma rutilans* which was allowed to rest on its edge in an almost vertical position for eighteen hours. Except for one or two above and below, which still remain in a vertical position, *all* the gills have undergone a certain amount of bending, which has tended to turn them back into the vertical plane. Figure 112 is also interesting in this connection. It represents a specimen of *Boletus chrysenteron* which was found growing out from a bank. The brave attempts of the spore tubes to become vertical are well seen in the photograph. Mushrooms have also been shown to reäct to the pressure of surrounding objects by elongation of the stalk. This is clearly an attempt to surmount obstructions, and carry the cap into such a position that it can effectively shed its spores. If the cap of an immature mushroom be surrounded by a ring, so that it cannot expand, the result is considerable elongation of the stem.

The presence or absence of light makes no difference whatever to the development of many fungi. Mushrooms grow equally well in the open fields as in a dark cellar; if lighted on one side only they show not the slightest tendency to turn towards or away from the light. The small Coprini, however, which grow on dung, and therefore among possible obstacles to the free dispersal of their spores, at first bend towards the light, but when clear of obstructions the stem becomes straight again to place the expanding gills in the best position for spore dispersal. Several other forms which grow on trees, and might therefore produce their fructifications within a hollow tree, where they would be of little value for spore-dispersal purposes, are markedly influenced by light. Curious, irregularly branched growths, similar to Figure 113, are produced by *Polyporus squamosus* when growing in the dark. Experimentally these seem to have no tendency to grow toward the light, and will only produce fructifications when exposed to light very early in their development. But in other species e.g., *Lentinus lepideus*, similar curved processes grow *toward* the light, and only when this is reached begin to develop into the spore-bearing fruits normal to the plant. Figure 111 is a curious example of the "Oyster of the Woods" (*Pleurotus ostreatus*). It should be compared with the normal fructification of the same fungus in Figure 115. It was found growing from a deep cleft in a beech tree in Epping Forest. The pale sterile column from the fungus plant, which measured eight inches in length, had been growing out from the interior of the hollow tree towards the light, and not until the light had been reached was a normal fructification developed.

Spore production in most of the larger fungi seems to take place equally by night and by day, and to be independent of light; so long as the fungus is not dried up it is also uninfluenced by the dryness of the atmosphere. Several of the woody forms have been shown to shed their spores at all ordinary temperatures from the freezing-point upwards; spore production takes place in *Lenzites betulina*, for example, at all temperatures between 0° and 30° C. Below freezing-point the formation of spores ceases, but many woody forms will stand freezing for months with reduction of temperature to −17° C., and yet start shedding spores within a few hours of being brought back to ordinary temperatures again.

We have now to consider a special group of fungi, the Coprini, or Ink Fungi, which, like the greater number of toadstools, have their spores distributed by the wind, but which differ from the remainder in many important details. Shaggy Caps (*Coprinus comatus*) is very frequently found growing on decaying refuse of all sorts, and is a very good example of this type. It is to be seen in Figures 110, 117, 118, and 119. Within twenty-four or forty-eight hours of the commencement of spore-dispersal the whole cap has dissolved into an inky fluid, and the stalk has more or less completely collapsed. Before liquefaction begins the fungus (see Figure 117) is cylindrical in form, with the gills pressed tightly together, but prevented from actually touching, except at their free edges, by a layer of thickened tissue in this region. The whole toadstool at this stage is pure white. But a change in colour now occurs, and the lower borders of the gills become pinkish and finally black; at the same time, the lower part of the cap expands a little, so that the toadstool is no longer cylindrical, but cone-shaped. At this stage, shedding of spores begins; but, unlike the other fungi of the mushroom type so far considered, the shedding of spores does not go on all over the gills at once, but the process is confined at first to their lower borders. As soon as these areas have shed their spores, auto-digestion and liquefaction of this region occur, and the fluid thus produced

either slowly evaporates if the day be fine, or collects in droplets at the outer edge if the air be moist. Meanwhile, however, the area of gill immediately above the liquefied portion is shedding its spores, and as soon as this function is fulfilled it is in turn cleared away, and so the process goes on. While successive areas of the gills are in turn shedding their spores, and then making a clear passage for the fall of other spores, the cap is slowly expanding, so that by the time spore dispersal is almost complete the cap, much reduced in size, is as flat as that of a mushroom or any other similar toadstool. If some of the dark fluid taken from a specimen of Shaggy Caps growing in the field be microscopically examined, it will be found to be practically free from spores. It is, moreover, without appreciable smell, and never seems to be eaten by insects, as was at one time supposed. It is merely the result of the dissolution of a tissue which has served its purpose and is of no further value to the plant. Remembering that the cap remains conical until almost the whole of the spores have been shed, that the stem is much less rigid than in most toadstools of equal size, and that the gills are very closely packed together, it will be seen that, were it not for the removal of useless tissue and the limitation of spore discharge to an area immediately above it, but few of the spores would ever reach the open air. If we look at the light hollow stem and thin flesh of the cap of *Coprinus comatus* it is quite certain that these would be insufficient rigidly to support the gills with their long axes in an exactly horizontal position, as occurs with toadstools of the mushroom type. Nevertheless, for a given weight of tissue used, *Coprinus comatus* is able to shed more spores into the air than is the mushroom. It must therefore be regarded as among the successes of the fungus world, and representing a high order of evolution; nor can we reasonably accept Massee's view that the Coprini are a primitive type from which the other Agarics have developed.

The Puffballs are another group of fungi that have their spores distributed by the wind. When the Giant Puffball (*Calvatia gigantea*, see Figure 75) is mature the upper half of its wall gradually breaks away, exposing a loose tissue which, with the contained spores, is gradually blown about and distributed by the wind. But in most Puffballs, instead of the wall breaking away irregularly, a small opening is formed above, and the wind entering here eddies round inside and carries away the tiny spores with it, or else, blowing across the top, produces a suction action with a like result. I have been much astonished at the quantity of water contained in certain Puffballs. Possibly this may be of value to the plant by raising up the more deeply placed spores which float on it, and thus bringing them nearer to the opening as the season advances. The Star Puffball (*Geaster seriscus*) is a beautiful fungus which differs from the Common Puffball in possessing a double outer coat: this splits into rays, which open out in a star-like manner when the spores are mature. Spore-dispersal takes place at first through the central opening of the inner coat as in other Puffballs, but later on the starry outer coat becomes dry and detached from the substratum, and the whole fungus blows about and the spores are shaken out. Bovista is another puffball with a central opening. It differs from Lycoperdon in the absence of a stalk and in possessing a smooth exterior entirely devoid of warts. When mature the whole fungus becomes detached from the ground and is blown about by the wind, shedding its spores as it goes.

(*To be continued.*)

THE ALCHEMICAL SOCIETY.

The eleventh general meeting of the Alchemical Society was held at the International Club, Regent Street, S.W., on Friday, March 13th. The chair was occupied by the acting president, Mr. H. Stanley Redgrove, B.Sc., F.C.S., and a very interesting lecture was delivered by Mr. B. Ralph Rowbottom, dealing with the life, thought, and influence of the English alchemist and philosopher, Roger Bacon. After stating that very little was known of the early events in Roger Bacon's life, the lecturer pointed out that two of the factors undoubtedly potent in the formation of his original and pregnant philosophy were his deep knowledge of mathematics, acquired during his stay at Oxford, and his study, at a slightly later period, of the best Arabic writers. The fact was next emphasised that, although Roger Bacon is usually known to us as an alchemist, his great achievement was the creation of a system, to be applied in the unravelling of the laws of nature, which was remarkably similar to that we to-day call scientific method. The lecturer proceeded to deal with several of Roger Bacon's works, pointing out the extremely short time in which the most important were written, and he finally gave the construction of the *Opus Majus* in detail. In conclusion Mr. Rowbottom suggested that the day will probably come when the name of Roger Bacon will no longer call to mind magic or "spooks," but a man who, born into an ignorant age, shed a light not to be considered negligible even in the present century.

The lecture was followed by an animated discussion.

The full text of the lecture and an abstract of the discussion is published in the March number of the *Journal of the Alchemical Society.*

FIGURE [illegible]. [illegible] *Pleurotus* [illegible] with [illegible] stalk [illegible]

FIGURE [illegible]. Shaggy Caps.—*Coprinus* [illegible] has [illegible]

FIGURE [illegible]. A [illegible] form of *Pleurotus ost*[illegible] from the side of a tree without any [illegible]

FIGURE [illegible]. Shaggy Caps.—*Coprinus comatus*, at the stage when its spores are being shed.

FIGURE [illegible]. [illegible] on the roots [illegible]

FIGURE [illegible]. Shaggy Caps [illegible]

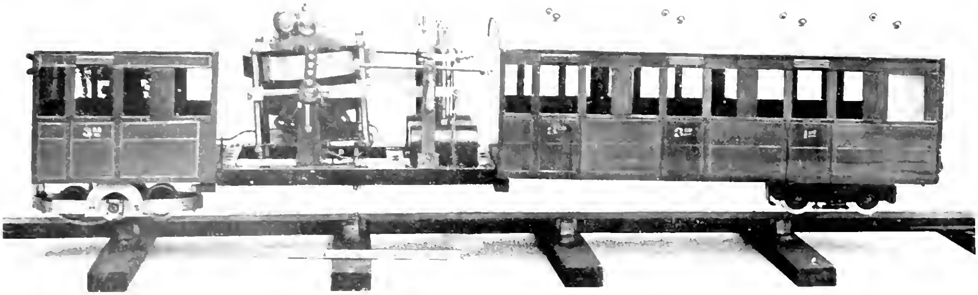


FIGURE 120. M. Schilowsky's Working Model Gyroscope Mono-rail Car.

The Gyroscope is seen freely exposed to view between the two carriages, and is placed, for inspection purposes only, far higher up than it would be in an actual carriage or train. This working model is driven by electric current, which moves the car and also revolves the horizontal gyroscope. In an actual carriage or train the gyroscope portion would be enclosed as in the motor car figured below.

FIGURE 121. M. Schilowsky's Motor Car on his Gyroscope principle.

A motor gyroscope car with the inventor seated beside the driver. The gyroscope is hidden, and is situated in the closed compartment between the driver's seat and the back seat. The two wheels here shown are ordinary tyred road wheels. For running on a rail these two wheels would be replaced by flanged ones for the purpose. The car and gyroscope derive their motive power from petrol.

THE SCHILOWSKY GYROSCOPE MONO-RAIL SYSTEM.

By J. HARRIS STONE, M.A., F.L.S., F.C.S

It came in as a spinning top. We hoped it would develop into a magic ameliorator of many mundane discomforts. Instead of working wonders it has simply shrivelled up, faded away into dusty, shop-soiled insignificance. Yes, it must be admitted that we are rather disappointed with the gyroscope. It has not come up to our expectations. A few years ago it was much to the fore, and everyone was dilating, of course with more or less exaggeration, upon the marvellous advancements which were to follow its adoption. We were to flash through the air on a car poised on a rail, or with lightning speed run up and down mountains suspended from a cable; when we travelled on the sea our vessels were no longer to give rise to sea-sickness, and in many other directions the practical utility of this marvellous piece of mechanism was to be demonstrated. These gyroscope marvels, or some of them, may even yet come to fruition, but just now they are embryonic.

The gyroscope is comparatively quite a modern invention. Its first practical application was in 1744, when Serson invented a spinning top with a polished upper plane surface for giving an artificial horizon at sea, undisturbed by the motion of the ship when the real horizon was obscured by clouds. That instrument was, we know, perfected by Admiral George Ernest Fleuriais, and Gilbert's baragyroscope, an improvement upon it, was devised for showing the Earth's rotation. Of course it has long been known that the gyrostatic principle, in which one degree of freedom is suppressed in the axis, is valuable for imparting steadiness to a moving body, and indeed an attempt to mitigate the rolling of ships with this instrument was made by Schlick. Then for a lengthy period the gyroscope hibernated and was lost sight of.

When Brennan's mono-rail car was exhibited at the Japan-British Exhibition in London a few years ago it caused quite a sensation. Many went specially to see and personally to try this much-talked-of revolution in passenger travel. Those who were fortunate enough to get a ride on the car came away mostly imbued with the idea that the gyroscope was too complicated for practical use. Brennan's invention was so frequently not working, or, as a notice board outside the gates said, "closed for repairs," that the majority of visitors to see the side-show went away without being able to satisfy their curiosity. From that day to this the invention has peacefully slumbered: it seems to have passed from the range of practical utility.

Abroad, particularly in Germany, much more attention has always been and is being devoted to the practical possibilities of the gyroscope than here. The German science museums consequently are far richer in examples of the recent developments of gyroscopic discoveries, inventions, and applications than in this country, but it is satisfactory to note that the authorities of our South Kensington Science Museum are increasing and enlarging the gyroscope department, and I am informed that they have the intention of still further paying increased attention to this important and coming branch of practical science. Better late than never; but it seems a pity that here, as with nearly every other branch of applied science, we seem always to be following suit, and never taking the initiative.

The latest addition to the gyroscope department of the Science Museum is a remarkable working model of a gyroscope mono-rail car which the inventor, M. Peter Schilowsky, has with delightful open-handedness presented to the nation. And here it may be noted that this model is the first model mono-rail car on this principle which has ever been shown to the public with all its working parts freely exposed for public inspection and criticism, so that its location at South Kensington is a distinct feather in the scientific cap of this country. On a curved mono-rail track the car can be seen travelling in either direction, weirdly upright, and quickly righting itself if depressed by external influence. M. Schilowsky, the donor and inventor, is a Russian scientific man, residing temporarily in London. He is quite an enthusiast as to the future possibilities of the gyroscope, and at the same time an idealist. He does not believe in keeping his inventions secret, but, with the true spirit of scientific camaraderie, allows everyone freely to probe and investigate what he has been able to do, trusting that other brains and other imaginations may still further add to and carry on his inventions, so that the day of practical adoption may be hastened. The many problems surrounding the gyroscope are by no means yet solved, but M. Schilowsky has unquestionably overcome some of the obstacles which hitherto have retarded progress. He is distinctly a pioneer in gyroscopic science, and there are only three or four other men similarly engaged, though the attention which will now be directed to M. Schilowsky's models may be the means of adding to the number.

In the first place he avowedly bases his system on that of Brennan. He uses a stabilising force obtained by a high-speed, rapidly revolving, heavy wheel—that is, a gyroscope. He has ingeniously

utilised its reäctive propensities against pressure for bringing it to its normal position when that normal position has been altered by pressure on the vehicle's lateral or vertical plane. His instrument differs from that of Brennan by being pivoted below the centre of gravity of the gyroscope. As we know, Brennan uses vertically spinning gyroscopes pivoted in the centre of gravity. Schilowsky's gyroscope is pivoted below the centre of gravity, thereby ensuring far greater stability of the vehicle in an upright position, and has specially designed mechanisms formulated on the principle of rachet device engagements for automatically restoring the right (here the horizontal) plane of rotation if it has been disturbed by any cause, such as pressure of the wind, the changing of places by persons inside the car, and so on. This corrective mechanism is automatically controlled by two heavy pendula which are sensitive to the slightest disturbance of the equilibrium of the car and instantly transmit to the gyroscope, through a rachet quadrant, an impulse just of the necessary strength to restore the equilibrium of the car and the right plane of rotation of the gyroscope. M. Schilowsky's system differs also from others in that his gyroscope works without airtight casing, without lubricating arrangements under pressure, and in several other subsidiary details.

The model car already constructed is worked by electric current, and so is the gyroscope. But in actual practice any other means of obtaining power can be employed to work gyroscope and vehicle. I timed the gyroscope at the Science Museum and found it ran and kept the car upright for over three minutes after the current had been cut off.

The gyroscope in the working model as at present constructed, makes some three thousand revolutions a minute, but in an actual car M. Schilowsky informs me that the maximum number of revolutions will be reduced to from five hundred to eight hundred, for the diameter of the actual gyroscope will be nearly that of the width of the vehicle, and so a great reduction in speed is obtained.

In order that the invention may be fully seen and even minutely inspected in the working model, the gyroscope is placed high up (see Figure 120) on the car and not cased in. In the actual car the gyroscope will be much lower and completely concealed. In the model too (see Figure 120) the gyroscope and its balancing machinery are exposed for the convenience of being inspected. In the actual car of course these machinery details would be enclosed.

M. Schilowsky has also already made an actual motor car (see Figure 121) on his principle, to hold six persons, the gyroscope of which makes one thousand revolutions a minute. This is driven by petrol and the wheels are made to run on a rail or on the ordinary road.

It is simply marvellous, almost uncanny, to notice, as M. Schilowsky's gyroscope revolves, how it automatically readjusts itself to the horizontal plane when by pressure on the frame, or from any other cause, it has been momentarily deflected. One cannot help the thought, on beholding the wonderful precision of the side rachet adjusting machinery, that the machine is imbued with a certain amount of animal intelligence. It is hoped that the inventor—or those who follow in his footsteps—will still further pursue his labours the outcome of which may revolutionise motor traffic on our roads, and make sea travelling devoid of all nauseating experiences. There are also many other directions where the application of gyroscope principles would be useful, especially as a stabilizer for aëroplanes.

The gyroscope is in its infancy, but it is not at all unlikely to grow into a potent power in the world in the near future. The greatest man that ever lived, we should remember, began life as a baby.

RADIOTELEGRAPHIC INVESTIGATION.

The Committee of the British Association which deals with radiotelegraphy is making a special investigation with regard to the effect on the propagation of electric waves of the total eclipse of the Sun, which takes place on August 21st, 1914. On this occasion there will be an exceptional and important opportunity of adding to existing knowledge of the propagation of electric waves through air in sunlight and in darkness, and across the boundaries of illuminated and unilluminated regions. The eclipse will be total along a strip extending from Greenland across Norway, Sweden, Russia, and Persia to the mouth of the Indus. In Russia the duration of totality will be a little more than two minutes.

There are two main points calling for investigation during the eclipse. In the first place the propagation of signal-bearing waves through air in the umbra and penumbra will probably obey laws different as regards absorption and refraction from those obeyed in illuminated air. In the second place the strength, frequency, and character of natural electric waves and of atmospheric discharges may vary.

To investigate the propagation of signals across the umbra it will be necessary to arrange for wireless telegraph stations on either side of the central line of the eclipse to transmit signals at intervals while the umbra passes between them. This transit of the umbra occupies about two minutes. It is thus very desirable that the Scandinavian and Russian stations should transmit frequently throughout several minutes before, during, and after totality.

The investigation of strays is of as great interest as that of signals.

The Committee propose to prepare and circulate special forms for the collection of statistics of both, especially within the hemisphere likely to be affected by the eclipse; they will endeavour to make provision for the transmission of special signals at times to be indicated on the forms; and they will offer for the consideration of the authorities controlling stations near the central line a simple programme of work. Digests of the statistics, together with the conclusions drawn from the analysis, will be published in due course.

The Committee would be greatly aided in the organisation of this investigation if those possessing the necessary facilities, and willing to make observations during the eclipse, would communicate with the Honorary Secretary, Dr. W. Eccles, University College, London, W.C., at the earliest possible date.

CORRESPONDENCE.

HIGH TIDE AT FREEMANTLE.

To the Editors of " KNOWLEDGE *"*

SIRS,—In the literature at my immediate disposal I cannot find any specific reference to the state of tides at Freemantle or in West Australia. There are, however, certain major disturbing influences which may in certain conditions produce important effects on the regularity of the tides. The Moon is not in general on the plane of the Equator, and hence there is a difference between its zenith and nadir distances. Consequently there is a difference in the tides corresponding to these positions of the Moon. This gives a diurnal irregularity or a "diurnal tide," which may interfere very considerably with the normal semi-diurnal. On the British coasts the diurnal tide is not noticeable, but in some places it may be as large as the semi-diurnal, or nearly so. On the coast of Queensland the diurnal irregularity is important, with the result that elaborate tide-prediction tables have been prepared for these seas. At Aden the tides are again complicated in this way, and twice a month one high water is obliterated. It is to be noticed that twice in the month the Moon crosses the celestial Equator, and the diurnal tide fails. Again, in estuaries, currents run up channel after the flow has ceased, and places some way from the sea have high water (and similarly low water) later than those on the coast. At such places there may be two or three rises and falls for one at the coast; thus there are two at Southampton. The times of rising and falling, too, may be considerably different, as in the Severn Estuary.

For a general treatise on the tides your correspondent may be referred to Sir G. H. Darwin's book on the Tides, and to his Bakerian Lecture on the subject (*Phil. Trans. Roy. Soc.*, A, 1891). The British Association Report for 1885 and the Admiralty Manuals (1886 *et seq.*) also supply information. These discussions are, of course, largely highly mathematical; but one knowing the local conditions, and possessed of the necessary mathematical equipment, could use them to gain accurate knowledge of the local effects of tidal influences.

A. STEVENS

GEOGRAPHICAL DEPARTMENT,
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DIARY OF A WASPS' NEST.

Early in the spring of 1913 I made several holes in the garden here, thinking that possibly a queen wasp might adopt the locality as a suitable spot in which to rear her brood. The idea was realised and I took a few notes:—

May 15.—Queen wasp took possession.

June 15.—The queen had made about eight hundred journeys to and from nest to this date when young wasps were first observed.

,, 16.—Queen flew from and to nest as usual in morning. At midday she crawled out of hole and seemed numbed and helpless. Picked her up and put her in the sun, but she could not nearly fly. Number of wasps flying to and from the nest per hour 16.

,, 18.—Queen came out of hole at 7.30 a.m., fanning with her wings and looking quite lively. Flew away at 8 a.m. and returned at 10.30 a.m. During her absence the young wasps remained at home.

,, 19.—Queen emerged fluttering her wings and moving briskly, as if intending to fly; but after remaining on brink of hole for half an hour she withdrew. So far as observed she never came out again.

July 6.—Number flying to and fro 136.
,, 15.— ,, ,, ,, 240.
,, 23.— ,, ,, ,, 397.
,, 26.— ,, ,, ,, 855.
,, 30.— ,, ,, ,, 1134.

Aug. 3.—Heavy thunderstorm. Rain water got into the nest and damaged it. The number of wasps seen declined after this date.

,, 15.—Number flying to and fro 744 per hour.

,, 20.—Young queens seen crawling about at mouth of hole.

,, 25.—About 40 queens flew away.
,, 28.—Hot day. 120 queens flew away.
,, 29.—Mostly cloudy. 95 ,, ,, ,,
,, 30.—Hot and fine. 165 ,, ,, ,,
,, 31.—Cloudy, cool. 40 ,, ,, ,,

Sept. 1.—Cloudy, rain. 20 ,, ,, ,,
,, 2.—Cloudy, cool. 20 ,, ,, ,,
,, 3.—Fine and warm morning. 225 queens flew away.
Sept. 4.—Cloudy and wet. No queens seen.
,, 5.—A few languid queens flew off.
,, 6.— ,, ,, ,, ,,

Altogether about 740 queens flew away.

,, 11.—The nest showing little signs of activity, I dug it out and found the rain had ruined it. Many dead wasps and queens. There were six terraces of cells, the largest pair being 6½ inches diameter. The whole included 4,800 individual cells.

In the spring of 1913 I think there was an unusual number of queen wasps about, due perhaps to the mildness of the preceding winter. This is a pretty populous neighbourhood, but I must have seen one hundred and fifty queens searching for domiciles in my garden during the months April, May, and June. They were chiefly observed in May; the last one noted was on June 9.

I used to sit near the nest and watch the interesting antics of the insects. The number of flies of different kinds they brought home was astonishing. The outgoing wasps carried away little lumps of earth to make room for additional cell accommodation. In June the wasps' working day was a long one, for they began soon after 3 a.m. and ended just before 9 p.m., so they were active during nearly eighteen hours.

But these facts are probably well known, and were indeed familiar to me more than fifty years ago when as a boy I cultivated wasps.

By careful observation close to the entrance I concluded that in July and August the daily number of flies brought home to the nest must have been three thousand or four thousand. Now flies in many respects are not regarded as agreeable additions to our domestic economy and comfort, so that if my wasps' nest provided the neighbourhood with one noxious insect it practically rid it of another.

My nest of 1913 was comparatively small. In my younger days I have taken them when containing from fifteen thousand to twenty thousand cells.

W. F. DENNING.

EGERTON ROAD,
BRISTOL.

THE FACE OF THE SKY FOR MAY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 18.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	[illegible]	[illegible]	[illegible]	[illegible]	h. m.	°	h. m.	°	h. m	°	h. m.	°	h. m.	°	h. m.	°
May [illegible]	[illegible]	N. [illegible]	[illegible]	N. [illegible]	1 43·4	N. 8·7	4 [illegible]	N.21·0	8 13·9	N.21·8	21 30·4	S.15·4	20 56·7	S. 17·0	7 50·1	N.20·6
[illegible]	[illegible]	[illegible]	[illegible]	S. [illegible]	2 11·4	12·6	4 26·4	22·3	8 24·3	21·2	21 32·6	15·3	20 56·9	17·0	7 50·4	20·6
[illegible]	[illegible]	[illegible]	[illegible]	S. [illegible]	[illegible]	[illegible]	4 52·5	23·4	8 34·8	20·5	21 34·4	15·1	20 57·0	17·0	7 50·8	20·6
[illegible]	[illegible]	[illegible]	[illegible]	S. [illegible]	[illegible]	20·1	5 18·0	24·1	8 45·5	19·8	21 36·0	15·0	20 57·1	17·0	7 51·3	20·6
[illegible]	[illegible]	[illegible]	[illegible]	N. [illegible]	4 27·8	23·0	5 45·4	24·0	8 56·2	19·0	21 37·4	14·9	20 57·0	17·0	7 51·8	20·6
[illegible]	[illegible]	N. [illegible]	[illegible]	N. [illegible]	5 12·5	N.24·5	6 12·1	N.24·8	9 7·1	N.18·1	21 38·4	S.14·9	20 56·8	S. 17·0	7 52·3	N.20·5

TABLE 19.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
[illegible] Noon.	°	°	°	°	°	°	°	h. m.	°	°	°	°	h. m.	h. m.
[illegible]	−24[illegible]	−[illegible]·9	[illegible]	+15·0	− 8·3	+12·7	137·1	2 37 *m*	−20·5	0·0	5·1	36·6	2 0 *m*	8 54 *e*
[illegible]	[illegible]	[illegible]4	[illegible]4·4	+20·3	0·8	13·6	85·1	5 54 *m*	20·6	−0·1	74·4	67·8	0 6 *m*	0 11 *m*
[illegible]	[illegible]	[illegible]8	[illegible]	− 4·1	5·3	14·0	41·0	9 11 *m*	20·8	0·1	143·8	99·1	8 3 *m*	7 11 *e*
[illegible]	[illegible]4	[illegible]	[illegible]	−21·1	3·7	15·5	352·0	0 29 *e*	20·9	0·1	213·3	130·5	6 0 *m*	8 23 *m*
[illegible]	[illegible]	1·[illegible]	[illegible]	−17·2	2·1	16·4	304·0	3 48 *e*	21·0	0·2	282·9	161·9	11 56 *e*	5 27 *e*
[illegible]	−17·1	−1·0	[illegible]	+ 0·1	− 0·5	+17·3	256·4	7 6 *e*	−21·0	+0·2	352·5	193·4	2 21 *m*	4 35 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}5$, $9^h\ 55^m{\cdot}7$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN continues its Northward march but with slackening speed. Its semi-diameter diminishes from 15′ 54″ to 15′ 48″. Sunrise changes from $4^h\ 38^m$ to $3^h\ 53^m$; sunset from $7^h\ 18^m$ to $8^h\ 3^m$. There is no real night at the end of May.

MERCURY is a morning star till 17th, when it is in superior conjunction, and is occulted by the Sun. Semi-diameter 3″. Illumination increases from [illegible] to Full, and then diminishes to [illegible].

VENUS is an evening star, [illegible] of disc illuminated. Semi-diameter 5½″. 2° 1′ North of Saturn on 16th.

THE MOON.—First Quarter $3^d\ 6^h\ 29^m$ *m*; Full $9^d\ 9^h\ 31^m$ *e*. Last Quarter $16^d\ 10^h\ 12^m$ *e*. New $25^d\ 2^h\ 35^m$ *m*. Perigee $8^d\ 8^h$ *e*. Apogee $21^d\ 4^h$ *m*, semi-diameter 16′ 40″, 14′ 45″ respectively. Maximum Librations. 2^d 7° E, 11^d 7° N, 14^d 7° W, 25^d 7° S, 29^d 6° E. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 21.)

MARS is advancing through Cancer. 20′ North of η on 9th, in Praesepe on 13th, 1° 38′ South of γ on 15th. Occulted by Moon on 30th, 5^h *e*. The semi-diameter during April diminishes from 3″ to 2½″. The unilluminated lune is on the East: its width diminishes from [illegible]″ to ½″.

JUPITER is a morning star. Polar semi-diameter, 18″.

Configuration of satellites at 3^h *m* for an inverting telescope.

TABLE 20.

Day.	West.		East.		Day.	West.		East.	
May 1	1	○	34		May 17	21	○	34	
,, 2		○	143		,, 18	2	○	314	
,, 3	21	○	43		,, 19	3	○	24	1●
,, 4	4	⊙		2●	,, 20	3	⊙	4	
,, 5	43	○	12		,, 21	432	○	1	
,, 6	431	○			,, 22	41	○	32	
,, 7	423	○	1		,, 23	4	○	123	
,, 8	41	○	3		,, 24	4½	○	3	
,, 9	4	○	213		,, 25	42	○	13	
,, 10	421	○	3		,, 26	431	○	2	
,, 11	4	○	31	2●	,, 27	34	⊙	2	
,, 12	3	○	42	1●	,, 28	32	○	1	4●
,, 13	321	○	4		,, 29	1	○	24	3●
,, 14	23	○	14		,, 30			1234	
,, 15		○	324		,, 31	12	○	34	
,, 16		○	1234						

The following satellite phenomena are visible at Greenwich all in the morning hours, $3^d\ 4^h\ 11^m\ 13^s$ I. Ec. D.; $4^d\ 2^h\ 47^m\ 49^s$ I. Tr. I.; $3^h\ 44^m\ 57^s$ I. Sh. E.; $4^h\ 12^m\ 11^s$ III. Tr. E.; $5^d\ 2^h\ 19^m\ 53^s$ I. Oc. R.; $11^d\ 1^h\ 58^m\ 59^s$ II. Ec. D.; $2^h\ 46^m\ 56^s$ III. Sh. E.; $3^h\ 22^m\ 58^s$ I. Sh. I.; $12^d\ 4^h\ 14^m\ 33^s$ I. Oc. R.; $13^d\ 2^h\ 9^m\ 35^s$ II. Tr. E.; $18^d\ 3^h\ 10^m\ 25^s$ III. Sh. I.; $19^d\ 2^h\ 27^m\ 36^s$ I. Ec. D.; $20^d\ 1^h\ 50^m\ 32^s$ II. Tr. I.; $1^h\ 59^m\ 58^s$ I. Sh. E.; $2^h\ 2^m\ 0^s$ II. Sh. E.; $3^h\ 18^m\ 44^s$ I. Tr. E.;

$22^d\ 2^h\ 20^m\ 6^s$ III. Oc. R.; $27^d\ 1^h\ 44^m\ 10^s$ II. Sh. I.; $2^h\ 55^m\ 10^s$ I. Tr. I.; $3^h\ 53^m\ 22^s$ I. Sh. E.; $28^d\ 2^h\ 28^m\ 57^s$ I. Oc. R.: $29^d\ 0^h\ 53^m\ 50^s$ III. Ec. R.; $1^h\ 49^m\ 6^s$ II. Oc. R.: $2^h\ 33^m\ 7^s$ III. Oc. D. Attention is called to the simultaneous presence of two satellites on the disc on the 4th and 20th.

The eclipses will take place to the left of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN is too near the Sun for convenient observation. 2° 10′ South of Venus on the 16th.

URANUS is a morning star, but badly placed.

NEPTUNE is an evening star in Cancer, semi-diameter 1″.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable. (See Table 22.)

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°		
Mar. May ..	263	+ 62	Rather swift.
Apl.-May ..	193	+ 58	Slow, yellow.
Apl.-May ..	290	0	Swift, streaks.
May 1-6 ..	338	− 2	Aquarids swift, streaks
,, 7 ..	246	+ 3	Slow, bright.
,, 11-18 ..	231	+ 27	Slow, small
,, 30-Aug..	333	+ 28	Swift, streaks.
May June ..	280	+ 32	Swift.
May-July ..	252	− 21	Slow, trains.
May 18-31 ..	245	+ 29	Swift, white.

In the cases where the radiant is stated to be active for several months, there is a difference of opinion as to whether it can be regarded as a single shower, or a combination of several.

TABLE 21. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reappearance. Time.	Reappearance. Angle from N. to E.
1914.			h. m.	°	h. m.	°
May 2 ..	BD + 24° 1806	7·0	0 31 *m*	130	—	—
,, 4 ...	45 Leonis	5·8	7 55 *e*	140	0 3 *e*	292
,, 5 ...	49 Leonis	5·7	0 14 *m*	111	1 9 *m*	309
,, 6 ..	Wash. 789	6·0	7 39 *e*	116	—	—
,, 8 ...	BD − 11° 3469	7·0	1 48 *m*	92	—	—
,, 10 ..	Lacaille 6719	6·0	—	—	10 47 *e*	305
,, 10 .	Stone 8802	7·2	—	—	11 31 *e*	289
,, 12 ...	Wash. 1120	6·8	—	—	0 36 *m*	192
,, 14 ...	BAC 6666	5·7	1 15 *m*	96	2 29 *m*	242
,, 17 .	ι Aquarii	4·4	1 53 *m*	41	2 58 *m*	268
,, 19 ..	Wash. 1574	7·0	—	—	2 28 *m*	234
,, 28 ..	BAC 2506	6·3	10 25 *e*	143	11 4 *e*	249
,, 28 ...	BAC 2514	6·0	10 57 *e*	160	11 20 *e*	225
,, 30 ...	Mars	—	5 6 *e*	145	6 16 *e*	278
,, 31 ...	Regulus	1·3	4 50 *e*	127	6 3 *e*	302

From New to Full disappearances occur at the Dark Limb, from Full to New reappearances.

Attention is called to the occultations of Mars and Regulus; both occur in daylight, but at a considerable altitude. They should be readily observable if the sky be clear.

TABLE 22. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
U Urs Min.	14 16	+ 67·2	7·6 to 12·0	327	April 21.
S Boötis	14 20	+ 54·2	7·7 to 13·0	273	April 8.
V Boötis	14 26	+ 39·2	6·4 to 11·3	258·5	May 8.
R V Boötis	14 36	+ 32·0	7·6 to 8·6	200	Feb. 4, August 23
R W Boötis	14 38	+ 31·9	7·3 to 7·7	unknown	
R Y Boötis	14 46	+ 23·4	7·1 to 7·4	9	Cepheid.
δ Librae	14 57	− 8·2	5·0 to 5·9	2·32735	Algol Star.
U Coronae	15 15	+ 32·0	7·9 to 9·1	3·452211	Algol Star.
R Serpentis	15 47	+ 15·4	5·8 to 13·0	357·2	May 10.

Minimum of δ Librae May $2^d\ 0^h{\cdot}9\ e$. Others may be found from period.
Minimum of U Coronae $2^d\ 9^h{\cdot}8\ e$. .. ..

Principal Minima of β Lyrae May $8^d\ 2^h\ e$, 21^d Noon. Period $12^d\ 21^h\ 5$.

A BRITISH FOLK MUSEUM.

By W. RUSKIN BUTTERFIELD.

(Illustrated from photographs by the writer and others.)

In the issue of "KNOWLEDGE" for August last an outline was given of a scheme for the utilisation of the Crystal Palace and grounds for a British Folk-Museum. Doubts have, however, been expressed, both in comments on the scheme in the daily Press and in private letters to myself, whether, in view of the sweeping changes that have taken place in these islands, and especially in England, the proposal has not come too late in the day for effective fulfilment. Happily, I believe such doubts to be unfounded.

Notwithstanding the wanton treatment to which our ancient buildings have been uncomplainingly subjected, there still survive numerous examples which will bear comparison, alike as regards antiquity and intrinsic merit, with anything to be found in the Continental Folk-Museums. In Sussex and Kent—the counties with which I am most familiar—I have been not a little surprised to find how many timber cottages and farmhouses belonging to the close of the mediaeval period still exist. These homely and picturesque dwellings, unlike the great houses of the land, owe little or nothing to foreign influence: they were constructed by native workmen from material provided by nature at hand and with loyal obedience to the traditional methods of the district; and herein lies this special value, for they portray the culture-status of the folk of the time, and not merely of their builders. They possess well-marked characteristics by which they may be readily distinguished, and as they throw light upon the home-life of the people at a time when social habits were very different from those of the present, a brief description may be attempted. Their external appearance is well illustrated by the Old Paper Mill, near Sandhurst, Kent (see Figure 127).

The ground plan of these houses is a simple rectangle. The roof is plain with a high-pitched central ridge, and the ends are usually hipped. A striking feature is their bilaterally symmetrical form; in other words, a line drawn vertically down the middle of the front wall divides them into two corresponding halves, and this is the case also if a line be drawn down the middle of an end wall. As a rule the upper story at each end overhangs in front, at the side, and at the back, thus giving a greater floor area to the rooms above. The original windows were mere unglazed openings in the walls, divided by two or more upright mullions of wood, square in section, and inserted with one of the angles to the front. The openings could be closed on the inside by means of sliding shutters. It will be seen that, besides the main posts, the battens in the walls are all upright, and they are set fairly closely together, the interspaces of lath and plaster being of about the same width as the battens themselves. This close and upright timbering is very characteristic of early work.

Originally the rooms were normally five in number and were disposed as follows: In the middle was the hall, which was open from floor to roof, and extended from the front wall to that at the back, the length coinciding with the recessed portion seen in the Old Paper Mill. At each end were two rooms in two stories. The upper room at the higher end of the house (that is to say, the end remote from the doorway, which never occupied a central position, but was always nearer one side of the hall than the other) was the solar or withdrawing room, and was reserved for the use of the family. Below the solar was a chamber, either whole or divided by a middle partition, running parallel with the front wall. The lower room at the opposite end (often divided in like manner by a middle partition) constituted the buttery and pantry, while above were the sleeping quarters of the domestics. The hall formed a common room for the family and dependents, and here meals were partaken of. Beyond a long table with its attendant forms for seats, and perhaps two or three chairs, it contained little furniture. The walls were mostly devoid of ornament, but their plainness was sometimes relieved by simple patterns "combed" in the plaster. At the upper end of the hall, however, was usually a panelled screen which gave distinction to the apartment. The chambers contained little beyond beds, chests, and chairs or stools. The fire was placed at the lower end of the hall, and as there was no chimney the smoke made its exit as best it could between the tiles or thatch or at the window openings or doors.

This, then, is a type of dwelling as distinctly national as anything can be, and at least one good example should be rescued and preserved in a national Folk-Museum before the opportunity shall have gone beyond recall.

The farmhouse near Ticehurst, Sussex (see Figure 130), differs from the one just described in being flat-fronted, though the ends are overhung; while in Stream Farm, Sedlescombe, Sussex (see Figure 128), is seen an innovation in the form of a gable at the upper or solar end. As the sixteenth century wore on a decided change took place in the social habits of the people, and the change is reflected in a departure from the time-honoured type of house. A need for greater privacy in the sleeping

FIGURE 122.
An 18th-century Staybusk.

FIGURE 123.
Carved Nutcracker.

FIGURE 124.
Carved Nutcracker.

FIGURE 125.
An 18th-century Staybusk.

FIGURE 126. The [illegible]

Figure 127. The Old Paper Mill, Sandhurst, Kent.

Figure 128. Stream Farm, Sedlescombe, near Hastings, a Fifteenth Century timber house.

Figure 129. A [illegible] Wittersham, [illegible]

Figure 130. Wardsbrook Farm, Ticehurst, Sussex.

Figure 131. Fireplace in the Malt House, Wadhurst, Sussex.

Figure 132. [illegible] Merchant [illegible] Rye, Sussex.

[illegible]

apartments began to be felt, which was met by constructing a room above the hall. The Westham house (see Figure 129) is a case in point. It will be observed that it overhangs along the whole front. Here is a second type of house that should be represented in a national Folk-Museum. About the same time chimneys began to come into general use with large recessed hearths. The great open hearth, or "down" hearth, to give it its local name, marks a decided advance in home comfort, and it became the family shrine, especially in winter, when the whole household would seat themselves within or in front of its capacious and hospitable opening. A series of fireplaces, showing the gradual changes that have taken place in the character of the hearth and of its many appliances, would form an attractive feature in a national Folk-Museum. The illustration of the "down" hearth at the Mill House, near Wadhurst (see Figure 131), will show how picturesque is an old Sussex fireplace, with its ornamental fire-back, its "dogs," chimney-crane, pothooks, trivets, and other objects.

During the seventeenth century other changes are observable in the smaller timber houses. Gables and dormer-windows are commonly introduced, and the close, upright timbering gives place to panels, often containing curved braces, while the main timbers, constituting the framework, are no longer enriched with mouldings. The interiors are more subdivided, and the rooms are consequently small and mean. Houses of this kind exist in plenty throughout Sussex and Kent.

It may safely be asserted that other English counties are not less rich in old domestic buildings. Suffolk is justly famous in this respect, and in the Guildhall at Lavenham (see Figure 126) it possesses a beautiful example of fifteenth-century English workmanship at its best. No one would wish to remove such a delightful building from its ancient site, even to grace a national Folk-Museum, but a faithful copy could be made of it. Essex likewise has a fine fifteenth-century timber house of small size in Paycocke's, Coggeshall. This, too, is well worth copying, although unlike the Lavenham Guildhall, which is a purely native product, Paycocke's exhibits pronounced foreign influence. Cheshire, Herefordshire, Worcestershire, Hertfordshire, and other counties also afford ample evidence that, in spite of the hasty and unconsidered clearances of former times, many small timber houses have escaped.

Thus, without considering the remaining parts of the British Islands, it is clear that there is no lack of suitable material, so far as domestic houses are concerned, for a comprehensive national Folk-Museum. But these houses are gradually disappearing, and unless a State refuge is provided to which the best of them can be removed when they are threatened with demolition there is very grave danger that they may be lost to posterity. As was explained in the former article, the houses on their reërection in the grounds of the national Folk-Museum would be restored to their original form, all subsequent alterations and additions being omitted, and they would be provided with the furniture and appliances appropriate to their period, size, and locality.

Leaving the subject of buildings, it must be admitted that in one category of objects there is a regrettable paucity—namely, objects displaying folk-art, such as the stay-busks and nutcrackers illustrated in Figures 122–125. One reason for this is that folk-art never seems to have flourished so extensively in this country as, for instance, in Sweden, Russia, and Switzerland; and another reason is that folk-art has languished from neglect. As Mr. Cecil Sharp truly observes: "We are apt, as civilisation advances, to imagine that art is the province of the rich and cultured; that only people who are very highly educated can appreciate art, and so forth. This is, of course, the reverse of the facts of history; because there is no art in the world that ever came into civilisation in the top story. All arts began at the bottom: they all came from people who could neither read nor write; they were all created, in the first instance, by the folk; and really the only fear of art becoming artificial or valueless is that it should be divorced from the folk from whom it sprang in the first instance." Before the days of complicated machinery and of extreme division of labour, workmen often fashioned the articles upon which they were employed from the first stage to the last, from the raw material to the completed product; and while the work grew under their hands they would elaborate it with ornament, drawing upon the traditional sources for their inspiration. Especially valuable are those objects made by men and women during intervals of leisure as presents or for use during some festival, as they are the highest expression of folk-culture. When a man carved a stay-busk for his sweetheart, or a maid embroidered a smock-frock for her bridegroom, the utmost skill at command was evoked and the utmost efforts were put forth. But it is precisely such things as these that the museums have hitherto neglected or at most treated with scant regard. The eyes of curators have been fixed in the ends of the earth, and the objects illustrating the culture-history of our own people have for the most part been overlooked.

A national Folk-Museum would concern itself exclusively, and as exhaustively as possible, with the peoples of the British Islands. It would trace the development of indigenous culture and characteristics; it would illustrate the home life, the occupations, the amusements, the inventions, the distinctive beliefs, the manners and customs, of the people of all grades and from the remotest times. It would hold up a faithful mirror to our whole past.

STELLAR SPECTROSCOPY FOR BEGINNERS. VI.

By PROFESSOR A. W. BICKERTON, A.R.S.M.

Reversal of the Lines of the Spectrum.

A spirit lamp in which soda is burning glows with a beautiful yellow light. If this flame is looked at through a prism fixed in a card, instead of the rainbow-tinted spectrum that would have been seen had the source been the limelight, we see the yellow flame displaced, yet looking exactly as it did without the prism. This is because, although the prism bends a pure tint, it does not separate it, as it has only one constituent.

If the limelight be placed behind this flame, the flame appears through the prism as a dark form on a brightly coloured background. This phenomenon is called isochromatic reversal; the cause of it is called sympathy of vibration. This sympathy, when clearly understood, is a principle of great importance in the comprehension of many phenomena, such, for instance, as wireless telegraphy, and beauty of tone in singing and instrumental music. It is also needed in understanding articulate language, and amongst many other things it is especially valuable in stellar spectroscopy.

There is at present a vicious tendency to apply science without comprehending its principles. Thus, without the student knowing basic chemistry, we teach its application to, say, gas manufacture, to soap making, to fluxes, to digestion, to dyeing cloth, and many special arts. Yet all very successful teachers will tell you that in order to apply science thoroughly to any art the quickest way to full success is to teach its basic principles.

This attempt to detach the art from the science has been the bane of the immediate past: it was nothing like so prevalent in the time of Faraday, Darwin, Huxley, Tindall, and Frankland. I was glad to see at their great conference a strong revolt on the part of science masters against this most vicious practice. The London County Council, who are now having five hundred non-vocational lectures given, are on the same right track; but it is a hard road. I have found that students tend to resent basic teaching intensely; they fancy they are not being taken the shortest cut. Really, of course, these first principles should be taught in the primary schools. When clearly explained and simply illustrated, children absolutely love basic science. To be successful, under good examiners, basic teaching is essential, and it is the same for one's own personal comprehension. So let us, as a striking instance, try and understand sympathy of vibration on which this principle of reversal and so much else depends.

Sympathy of Vibration.

Look at a child swinging another: it gives a slight push, then carefully timing the second impulse the swinging child moves further. When a score or so of well-timed pushes had been given, the latter goes high into the air. So an elder child on a swing gives a movement of its legs, keeps timing these movements, and presently carries itself so high that the ropes are momentarily horizontal in the air.

If we have two tuning-forks of exactly the same pitch, each on a good resonating box, on making one sound loudly, and then stopping it suddenly, the other will be found to have taken up the note. The first fork gave impulses to the air, the air pushed the other fork and kept pushing it exactly in time, and so its vibrations grew larger and larger. Stick a piece of paper on the prongs of the second fork and it moves more slowly and is out of time, and there is no sympathy. Resonance is another example of the same kind. Take a singer's tuning-fork, vibrate it, and hold it over a tumbler; there is no reinforcement of the sound. Partly cover the tumbler with the hand and hold the fork in the contracting space; presently at a certain-sized opening, when the time of the periods of the vibrating air corresponds with those of the fork, the tone bursts forth loudly.

Like the isochronic tuning-forks, all atoms of sodium have the same note; if some are vibrating they make the other atoms of sodium vibrate also; but they do not act on atoms of other elements. An atom picks up its own rate of vibration out of white light, because such light is of all lengths and one or several of these lengths corresponds with the rates of the atom's vibration. We have seen how a prism alters the position of a sodium flame without altering its appearance; also when a limelight is placed behind the flame, it appears dark.

In Figure 133 a limelight is shining through a sodium flame. The light is somewhat diffused by passing it through slightly ground glass. Some of the rays from the limelight go through the flame. The isochromatic vibrations affect the sodium atoms, and these vibrations are taken out of the white light. The atoms in the flame send off these vibrations in all directions, backward as well as forward; so the rays of the limelight falling on the prism are largely robbed of that particular wave-length. The light from the flame is still there, but the limelight is so much brighter

than the soda flame that the flame seems dark by comparison (see Figure 131). If we use a good spectroscope with a very narrow slit instead of a naked prism, we find that the yellow light is made up of two tints, and a pair of bright lines are seen. These lines also become dark when in front of the limelight.

The Fraunhofer Lines.

We have simply to apply these principles to the Sun, and we easily understand the black lines seen in its spectrum. The outer surface or limit of statical equilibrium of the mixed gaseous sphere, the limit we call the photosphere, is intensely hot. Outside of this surface is a layer of mixed vapours that is dynamically supported by the volcanic action occurring all over the solar surface. This layer is some six hundred miles thick, and is cooler than the photosphere. It is called the reversing layer, because it is gases in this layer that are chiefly concerned in giving the black lines in the solar spectrum. Outside of this layer is another, less dense still. This very rare ensphering shell is supported by molecular velocity: it consists largely of hydrogen, which gives it a red tint; hence it is called the chromosphere. This ensphering shell or layer is some thousands of miles through. We see the lines of these elements bright in integrated flash spectra (see Figure 523, "Knowledge," December, 1913), and as bright circles or segments of circles in Worthington's differential spectrum (see Figures 521 and 522 on the same page). A somewhat full account of the probable constitution of the solar layers was given in "Knowledge," February, 1912, pages 52 and 53.

Coincidence of Bright and Stellar Reversed Spectra.

Figure 139 shows the carbon spectrum as seen glowing in the electric arc and that seen in the spectrograms of fourth-type stars: it is a very beautiful example of reversal. It would be difficult to imagine anything more striking than these wonderful series of coincidences of luminosity and shading that Professor Hale has so clearly contrasted in this exquisite photograph.

We have now to apply the double effect of reversal and Doppler's principle in order to try to understand what are called winged lines; afterwards to the broad black bands of Sirian stars, then to the displaced lines and bands of novae, and to the mixed lines to be found in variables and Wolf-Rayet stars.

Winged Lines.

Before an electric spark is produced, the potential rises and attracts gaseous particles. There appears to be a kind of elastic atmosphere that extends to some distance from the nucleus of the atom. This atomic extension probably causes gaseous adhesion and a number of other phenomena. This atmosphere appears to be a non-conductor of electricity.

As the potential rises the electricity acts inductively and attracts the atoms or molecules more strongly. Presently in their excursions, when the potential is high enough, some of the atoms are so strongly attracted, and hit so hard, that they come close enough to carry off electricity. A strong repulsion follows, and the molecules fly away; as they return they hit harder, and consequently nearly all the electricity is taken away and the potential falls almost to zero. Generally it soon rises again and another spark follows. As the excursions of the atoms are in all directions Doppler's principle comes in; and as the light falls on the slit of the spectroscope the lines broaden. Suppose we interpose a lens, and the image of the poles and spark be formed on the slit of a differential spectroscope, we get a detailed spectrum. If we take a "long line," that is, an overtone that does not die down quickly, it carries its vibrations from pole to pole, but the very high speed of the atom in space only reaches a short distance from the poles. Hence the lines are only wide near the poles, so with a narrow slit the lines appear as in Figure 61 (see "Knowledge," March, 1914). But the outer atoms are cooler than those near the pole, and the light rays shine through the outer layers and sometimes suffer reversal; and because the outer atoms move slowly we have a dark dart in the centre (see Figure 136). Where the vibration is very long sustained the reversal may reach from pole to pole. Instead of being parallel to the slit the image of the spark or arc may be thrown across the slit, as shown in plan, "Knowledge," January, 1914, Figure 16.

Clearly either the pole or the centre of the arc can be on the slit. If we use the centre, the appearance of a "long line" will then be a wide line, due to the velocity of the centre or core of the arc, and the outer atmosphere, being cooler and consequently not moving so fast, will show a thinner reversed line. The spectrum of some elements, then, consists of long and short lines, some of them with reversal in the centre (see Figure 137). We may also get a spectrum without reversal, as shown in the beautiful example kindly enlarged by Professor Fowler (see Figure 135).

This reversal will explain the broad bands of Sirian stars. The breadth may indicate the temperature of the gas immediately outside the photosphere of those stars. The width of the bands in some cases represents something like two hundred miles a second, indicating an almost inconceivable temperature.

The broadening of these bands cannot be due to the rotation, as there are also the thin lines of other elements. In our Sun's atmosphere calcium shows broad bands. But calcium, as we know it in chemistry, has an atomic weight of forty; yet it is seen high up on the chromosphere, suggesting that the atom is broken up, and this broadening of the calcium may be due to the combined action of pressure and disruption. These are interesting problems as yet unsolved.

If the explanation of the above phenomena is unsatisfactory this cannot be said of the spectrograms of novae, which we will now try to understand. The evidence seems indisputable that a nova is a third body torn from grazing suns. Owing to the immense distance separating the stars that are nearest the Sun, some astronomers doubt if there are many stellar collisions.

There are, however, fully a dozen agencies, tending to produce solar impact, that probably render grazes some one hundred thousand times more frequent than mere random encounters.

Solar collisions, instead of being accidental and destructive, are probably a law of nature, and constructive. The cosmic sparks struck from clashing suns are probably the most suddenly stupendous phenomena in the whole realm of nature.

Granting that suns collide—and it seems certain by the mass of corresponding phenomena of novae that they do—some of the salient phenomena are not difficult to deduce. A graze of two similar suns must produce a third star that is an exploding sun. The phenomena common to all novae show that these brilliant ephemeral bodies are exploding suns, and the only rational explanation yet given of the mode of production of an exploding sun is a solar collision.

Anyway, it is certain that were a pair of similar suns to collide, so as to graze off, say, one sixth, a nova would undoubtedly be produced. The deduced body would possess all the many characteristics that are the criteria of novae.

The Series of Spectra of the Third Star.

The series of spectra of the third star struck from grazing dead or vivid suns would pass from that of an ordinary star through a remarkable series of changes. At birth every atom is above the critical velocity. That is, were the new star all of one element, every atom would be projected beyond the third body's attraction and be dissipated into free space.

But as it consists of many elements two laws of the dynamical theory of gases come into play. At the moment of the encounter the various elements acquire a temperature tending to be proportional to the atomic weight. The atomic weights of hydrogen, helium, and oxygen are respectively one, four, and sixteen, and the temperature of helium will tend to be four times, and that of oxygen sixteen times, that of hydrogen.

As they mix, these differences of temperature tend to equalise. Were they to become the same, then the molecular speed would be inversely as the square root of the atomic weight, that is, helium would move twice as fast as oxygen, and hydrogen twice as fast as helium.

Sorting of the Atoms.

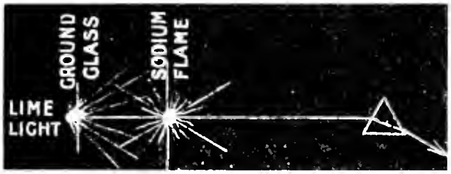
There is thus a tendency for the atoms to sort themselves into a series of ensphering shells, but there are apparently many agencies, such as gaseous adhesion, that tend to prevent this completely happening.

Some of these we must discuss later when we deal with the details of the spectrograms. At present we will discuss and explain one aspect of the problem, the one that up to quite recent meetings of the Royal Astronomical Society has proved puzzling to astronomers.

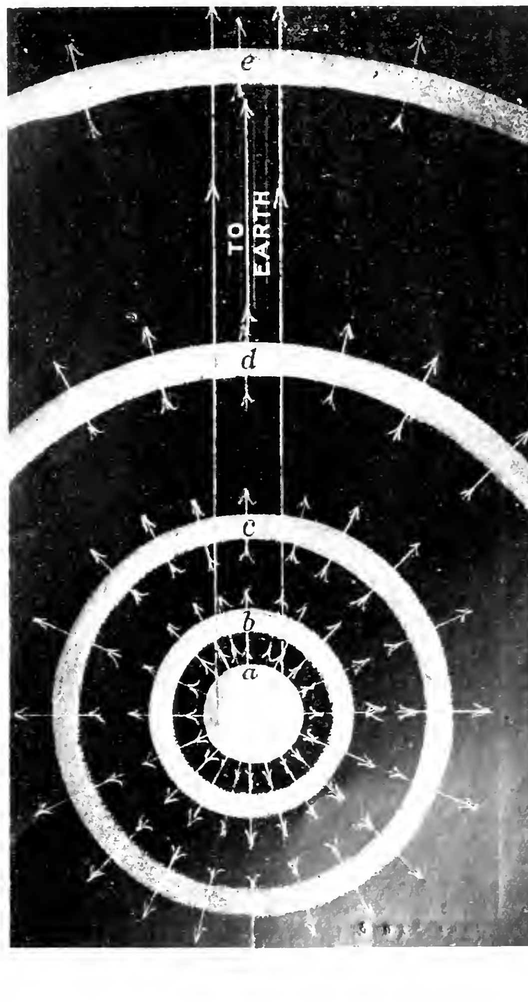
This is the fact that the black lines of the elements are displaced so as sometimes to show on Doppler's principle a velocity of approximately a thousand miles a second coming our way; and these lines die out without lessening displacement.

We have already seen how the series of bright bands of novae have been produced. Some astronomers argue that these are due to pressure, but that is clearly wrong. One has only to look at the fine spectrograms of Nova Persei, made at the Solar Physics Laboratory at South Kensington, in which a comparison star is included, to see that the widening of the bright bands is on both sides of the black band of the comparison star, to know this widening cannot be due to pressure which extends the spectrum towards the red. In "Knowledge," September, 1911, Figure 7, a portion of one of these spectrograms was given that shows this fact in both the two bands copied. The same fact is shown by the Huggins' spectrogram of Nova Aurigae compared with the solar spectrum in their atlas of representative spectra. These bright bands are really sufficient evidence of expanding spheres, but when we come to treat of the tremendous displacement of the black lines the evidence for the theory of an exploding Sun is conclusive. In "Knowledge," September, 1911, a full statement of the dynamics of the cosmic spark struck from grazing stellar flint and steel was fully developed; also in "The Birth of Worlds and Systems," Harper's Library of Living Thought. Sufficient now to say that an ensphering shell of light gases separates from a brilliant nucleus of the heavier elements. The nucleus attains a definite oscillatory volume. The shell or shells expand continually. In Nova Persei this expansion, as indicated by the spectrograms, was at the rate of a thousand miles a second. In Figure 138 the sequence of the phenomena is shown: (a) shows the light gases emerging from the brilliant nucleus. As they are mainly in front of it they produce black bands, which show a little luminosity on the edge towards the red.

Next, the shell as shown has arrived at (b): all the portion of the shell in front of the nucleus between the parallel white lines on the diagram reverses the light of the nucleus, which is white and gives a continuous spectrum. The remainder of the shell at (b) that is not eclipsed by the nucleus, as it is moving in all directions, gives a broad bright band. As the reversing part of the shell is coming our way we get black bands on the edge towards the violet, as seen in Nova Aurigae as given both by Newcomb and Huggins, and as taken of Nova Geminorum No. 2 at Greenwich and the Imperial


GROUND GLASS
SODIUM FLAME
LIME LIGHT


V I B G O R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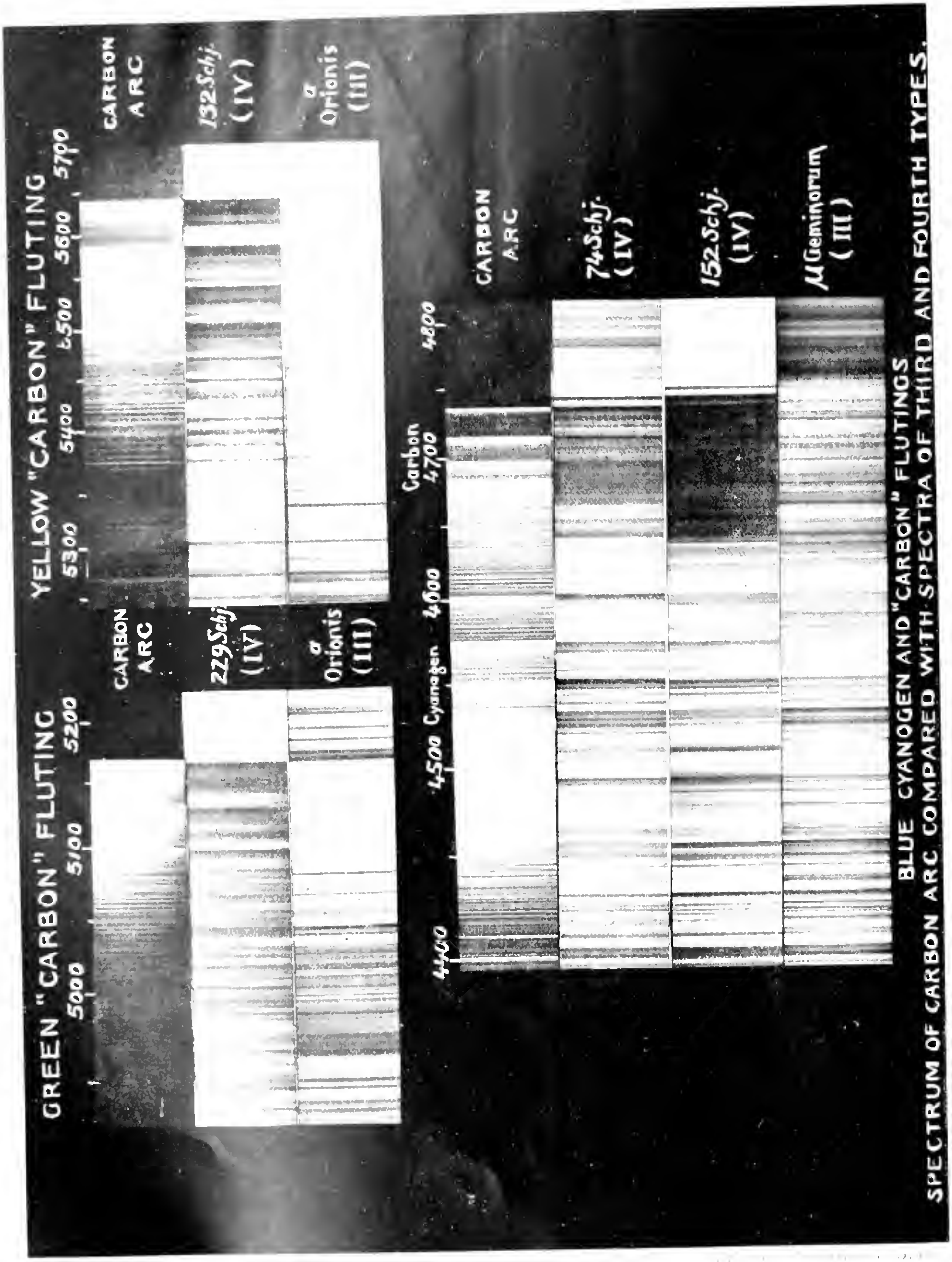


SPECTRUM OF CARBON ARC COMPARED WITH SPECTRA OF THIRD AND FOURTH TYPES.

College of Science. Again we draw the shell still further expanded. The shadow line is narrower, but has the same displacement, because the shell has not appreciably diminished its velocity. It is narrower because the resultant of its velocity differs less. All these peculiarities show beautifully in the spectrograms of Nova Persei.

When I came to England the authorities of the Solar Physics Laboratory kindly gave me a positive of their series of spectrograms of Nova Persei. These so far as above described bore out my theory, but I was disappointed because I had deduced that the shell should as time went on become so attenuated as to have no power of reversal, and consequently the black lines should die out, with lessening displacement, long before the bright bands should disappear (see (c) and (d) of Figure 138).

Then I came into possession of the series of spectrograms by Father Sidgreaves taken at Stonyhurst, and extending to a much later date than the South Kensington series: there was all the evidence I wanted. One saw the thinning of the line to a mere thread, and its disappearance. Several of the later spectrograms show no sign of a black line, much less of anything like a shadow band (see Figure 8, "KNOWLEDGE," September, 1911).

Thus fact after fact backed up the theory, but the deduced physical properties of the third body were many and various. What was my delight to see almost all of them showing themselves, more perspicuously than a written description, in the wonderful Cambridge series of spectrograms of Nova Geminorum, exhibited nearly two years ago in the library of the Royal Astronomical Society. To my great disappointment these spectrograms were not yet available for public use when I last applied for them. When they are so available no trace of doubt that these spectra represent stages in the development of the third star struck from grazing suns can remain in the minds of anyone who can read the spectra and understand the theory of the thermodynamically unstable body that must be formed when stars graze.

Before further developing the details of the spectra of novae we must treat of the spectrograms of the four chief orders of stars and their minor subdivisions.

Already enough has been said on some of their peculiarities to show how many difficult problems the spectroscope has solved, and the marvellous revelation of the wonders of cosmic space it has unfolded.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

MR. D'ESTERRE'S OBSERVATORY AT TATSFIELD.—I have already alluded to Mr. D'Esterre's work, which affords useful suggestions to amateurs as to lines of research that are likely to prove fruitful. He has selected a limited area of sky (the Milky Way about Perseus and Cassiopeia) and keeps a continuous photographic watch upon it, both with a portrait lens and larger apparatus. He has already been rewarded by the discovery of one possible Nova and many variables. The total area surveyed is one thousand square degrees, or $\frac{1}{41}$ of the entire sky; and as his observations cover three years, he has enough material to lay down the following statistical results: (1) Not more than one in five thousand of stars fainter than the tenth magnitude varies one magnitude. (2) No Novae have been discovered whose maximum brightness is less than magnitude 12. This suggests a strictly limited size for our stellar universe. If it were a million light years in radius (as suggested by Professor See) these faint Novae would be far commoner than bright ones. (3) Faint variables do not disappear at minimum, but remain visible, of magnitude 18 or brighter. This also favours a limited universe. (4) He concludes that the variables are red at maximum, from their visual brightness exceeding the photographic. At minimum the two methods give the same brightness. He suggests that they are very distant, and that the maximum, not the minimum, is the abnormal event in their history.

This comparison of visual and photographic magnitudes is a ready way of determining the spectroscopic type of the fainter stars. For this purpose the visual determination may be replaced by photographs taken with special plates that are sensitive to red. Professor Seares contemplates such a series with the 60-inch reflector at Mount Wilson.

THE PLANET JUPITER.—The Rev. T. E. R. Phillips gave an account of the aspect of this planet in 1913 at the December Meeting of the British Astronomical Association. The peculiarity of the aspect was the number of egg-shaped markings at the northern edge of the great belt in the north equatorial region. These features favoured an accurate determination of the rotation period of this belt. It proved to be unusually rapid, and Mr. Phillips suggested a cyclical variation of period in about thirty-three years. In 1879 the period was exactly 9h. 50m.; in 1889 it had risen to 9h. 50m. 30s., remaining near this till 1900, when it began to diminish; last November it had fallen to 9h. 50m. 10s., so that it seemed to be reverting to the 1879 value.

Herr H. E. Lau gave in *Astron. Nachr.*, No. 4673, an investigation of the variable rotation of the Great Red Spot. An analysis of the observations from 1903 to 1910 led to the conclusion that it had a regular oscillation in a period of 1·9 years; when the results are plotted in terms of this period, they fall along a curve resembling a sine curve, but with a singular flattening from 1·4 to 1·9. In view of the puzzling motion of this spot, I am glad to see that the American Nautical Almanac for 1915 has abandoned the attempt to use this spot as the zero meridian for the temperate zones of Jupiter, and has reverted to the meridian that has been in use in this country for twenty years.

There can be little doubt that the 1·9 year perturbation of the red spot is due to the influence of the dark marking that overtakes it at intervals of this length. Herr Lau has also plotted the longitudes of this marking in a 1·9 year period, and finds a marked disturbance at the time that it is passing the spot, while for the rest of the time the graph is horizontal.

Herr Lau gives some general conclusions as to the condition of Jupiter, which are interesting.

(1) The equatorial diameter at its mean distance is $37''\cdot6$, polar $35''\cdot4$, compression $\frac{1}{17}$.

(2) The visible surface is a yellow, highly reflective cloud layer: over this there lies a thin layer, whose apparent depth is a few tenths of a second

(3) The angular rotation in twenty-four hours of the surface layer is 880°·2 at the Equator, 870°·3 at the Poles. The limits of the equatorial current are about 7° north or south latitude.

(4) The limits of this current are the true spot zones. The belts arise as dark spots, which subsequently spread out, both in longitude and latitude.

(5) The bright spots stand over hotter regions of the interior. He considers that their brightness fluctuates synchronously with the period of sunspot activity.

(6) The red spot is an abnormally hot region in the deeper layers of the gaseous interior. The "Bay" encircling the spot arises from the currents in the upper cloud layers, which push back the material of the belt.

(7) The mutual influence of the dark marking and the red spot on each other's motion arises from the streaming of gaseous currents from all sides towards the red spot, where they descend to lower layers.

(8) The disturbances in the motion of the "Bay" arise from the motion of the cloud masses overlying the red spot.

We are apt to forget that the red spot that we see is only an effect of a disturbed region deep down in the planet, and that it does not follow that this deep region shares in all the fluctuations that the surface markings show.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

AN ORCHID WITH EXPLOSIVE FLOWERS.—Dr. H. N. Ridley (*Straits Settlements Gardens Bulletin*, Vol. I, 1913, pp. 191–3) describes an orchid from Sarawak which shows a remarkable floral mechanism. This species (*Plocoglottis porphyrophylla*) is widely distributed in Malaya, but being inconspicuous and a lover of deep shade is but little known. It bears only one flower open at a time, but remains in flower for over three months, producing a fresh flower every few days until the raceme is more than two feet long and has borne about fifty flowers. Unfortunately the author's account is not accompanied by illustrations, but the following description may be followed if the reader examines any ordinary orchid flower. In the young flower the ovary begins to twist, as usual in orchids, until it has overtopped the bract : it carries the swelling bud through about seventy-five degrees and then stops twisting. During this twisting the dorsal sepal outgrows the other two sepals and pushes over the apex of the bud. All the sepals at this stage are similarly narrowly ovate, the lateral ones asymmetrically so. The lateral petals are linear and curved round the column to meet at their tips. The lip is about as broad as long, cuspidate above its broad shoulders, with the margins in the lower part frilled and turned under —if these margins are uncurved it is seen that they are the lateral lobes of the lip. Under each broad shoulder a wart has begun to form. Between this stage of the bud and maturity the following changes occur. The contiguous halves of the lateral sepals thicken from the middle upwards ; the cuspidate tip of the lip turns back, its shoulders enlarge, and the warts become sharp little upstanding cones, while the side lobes increase along their margins so that they are too full for the space they have, and towards the base of the lip tend to form an upstanding rounded crest : two very fleshy staminodes lie within the curve of this crest, one on each side. In opening, which occurs in late afternoon or early evening, a slit appears between the lateral sepals ; then these sepals break away and slowly take up a position at right angles to the ovary, and their thickened areas become convex inwards and throw the thin parts back ; then the lateral petals rapidly elongate, curving over strongly so that their points pass between the bases of the lateral sepals, and in this curious action they deflect the lip on to its base, holding it down against a certain amount of resistance, in contact with the lateral sepals ; thus the flower gapes somewhat. During the night the dorsal sepal turns back and the lateral petals straighten. The upper lateral sepal, no longer held away from its fellows by the lateral petals, now moves down to be in contact with it, and is thus almost median as regards the lip, and as the lateral sepals move away, the lip is caught against its convex swelling and held folded down as the lateral petals placed it. A touch now frees the lip and causes it to spring up against the column. It is apparently fertilised by rather small insects which, attracted to the flower, are trapped by the upspringing of the lip against the column, and in struggling to free themselves effect pollination. The mechanism is very curious : the lip is a trigger put into place by the lateral petals and held there by one of the lateral sepals. This alone makes it of unusual interest, but this is heightened by the angle at which the flower stands, by the movement out of the median line of the column, and by the movement toward it of a lateral sepal. The flower has apparently no scent and no free honey : its colours are lemon-yellow to yellowish-green with deep crimson markings on the lip, and the swollen parts of the lateral sepals are maroon.

MARINE VEGETATION OF THE ADRIATIC.—Schiller (*Urania*, Bd. 6, 1913, pp. 382–386) gives a general account of the more striking botanical results of the recent joint Austrian and Italian survey of the Adriatic. He distinguishes three vertical zones of marine vegetation in this sea. (1) Littoral zone, down to low-tide mark, with *Enteromorpha*, *Bangia*, *Porphyra*, *Fucus*, and so on. (2) Sublittoral zone, from low-tide mark to about forty metres depth, with *Bryopsis*, *Cladophora*, most of the Phaeophyceae, *Callithamnion*, many calcareous Algae, and so on. (3) Pelagic zone, down to two hundred metres—this zone presents several features of interest in the Adriatic. Practically no attached Algae are found at any great depth in this sea, the floor of which is very muddy, though down to about one hundred and sixty metres there is an abundant vegetation of calcareous Algae which provides a firm substratum to which are attached such plants as *Laminaria*, *Calophyllis*, and so on. Practically the only plants attached in the loose material of the bottom, and then only near the coast, are *Zostera* and *Posidonia*, which, owing to their roots and rhizomes, are able to colonise sand and mud.

Though some of the Algae show continuous growth, that of the majority is limited to a few months, the periods of activity of the algal vegetation being (1) from the beginning of February to the end of May, (2) from the beginning of October to the middle of November ; hence there is a summer and a winter resting period. Further observations are being made with reference to this periodicity, the causes of which remain obscure. Diatoms are abundant as epiphytes on other plants at all depths, as well as in the plankton, and the latter (chiefly found in the upper seventy metres of water) is very varied, including Peridineae, Coccolithophoridae, Flagellata, and Silicoflagellata. The plankton shows the same general periodicity as the attached vegetation, its maxima and minima occurring in the same months. The author compares the vegetation of the Adriatic with that of the Baltic near Kiel, and notes that the former is relatively poor in quantity, especially as regards the plankton, which is only about half as abundant.

VEGETATION OF THE ARCTIC - AMERICAN ARCHIPELAGO.—Simmons (*Lunds Univ. Arsskr.*, 1913, 183 pp., 2 maps) summarises the botanical results of the various exploring expeditions to the archipelago lying to the far north of the American continent, and shows that this may be divided, both geographically and geologically, into several island groups. The climate is very dry, the annual precipitation in Ellesmere Island, for instance, being less than one centimetre. This is evidently the reason for the very slight glaciation of the area at the present day, and from the absence or slight traces of former ice-covering it is inferred that similar conditions existed during the Glacial period, when the adjacent portion of the continent was covered by a great inland ice-sheet. The author gives tables of temperature observations in different parts of

the area and lists of the plants recorded, with their habitats. He notes that it is hardly possible to distinguish between calciphilous and calciphobous species in this region, and that the poverty in species of the flora in Silurian rock-soils is probably attributable to the dysgeogenous nature of the Silurian limestone. The absence of endemic species is regarded as proof of the complete expulsion of the pre-Glacial flora (the present-day circumpolar species) during the Glacial period and their subsequent return in Postglacial times. In discussing the means by which the archipelago was populated after the Glacial period, the author points out that marine drift probably played a very small part, and that ice was important only in so far as seeds are readily carried by wind over the frozen water-surface separating the various islands. The flora consists mainly of perennials, and over ninety per cent. are adapted for wind-dispersal; the few species with fleshy fruits are chiefly distributed by ptarmigan.

The view that the Arctic-American archipelago was denuded of plant-life during the Glacial period is, the author claims, confirmed by geological evidence. During this period the frozen polar sea was surrounded by land, but later, owing to land sinking, this sea became connected with the open sea to the south. The ice melted first in the western portion, so that the return of vegetation took place from west to east along the coast of the mainland and over Banks Land and Victoria Land; the western element forms a considerable part of the flora of the archipelago and of Greenland. Later the Keewatin ice-sheet retreated so far eastwards that plants could colonise King William Land and Boothia Felix. Still later, when the land between the Keewatin and Labrador ice-sheets became ice-free, plants migrated northwards along the western shore of Hudson Bay, and others came from the south (from eastern North America) via Labrador and Hudson Strait to Ellesmere Land and Greenland when the Labrador ice-sheet melted. The flora of Greenland consists largely of American species; even in East Greenland more than half of the species are American, while the flora of Ellesmere Land is entirely American. That the entire Greenland flora is of Postglacial origin is indicated by the presence of only four endemic species.

VEGETATION OF THE FALKLAND ISLANDS.—Skottsberg (*Sven. Vet. Akad. Handl.*, 1913), who has done so much in the investigation of the ecological plant geography of far southern lands, published in 1909 an account based on his first visit to the Falkland Islands, and the present paper is the result of a second and longer stay there. The Falkland Islands, an outlying portion of the British Empire, form a group of about two hundred islets off the east coast of the southern end of South America, with a total area of about six thousand five hundred square miles, of which the two chief islands, East Falkland and West Falkland, make up over five thousand. The islands of this archipelago are mostly mountainous—the highest point, Mount Adam, is about seven hundred and fifty metres—with much indented coasts, the climate is cold and wet, wheat will not ripen, and there are no trees—the tallest native plant is a woolly ragwort (*Senecio candicans*) about 1·5 metre high. Much of the interior is covered by thick peat formed largely from *Empetrum rubrum*. The total native vascular plant flora includes one hundred and sixty-two species. Of these one hundred and thirty-three are common to South Patagonia and Tierra del Fuego, fifteen are endemic, and fifteen form a "thermophile" element, since they occur mostly in South Chili and some also in North Patagonia, but not in South Patagonia or Tierra del Fuego. Among the new species described for the Falklands there are several ferns previously known only from the west coast of South Chili and Tierra del Fuego: these appear to be limited in the Falklands to the West Falkland island, which is milder and wetter than East Falkland. Some species in the Falkland flora are limited to the West island (twenty-four) and others to the East island (thirty).

From the geological and botanical results obtained by the Swedish expeditions it would appear that in the Tertiary period the Falkland Islands were less widely separated from the mainland than now, and were probably connected with it. Moreover, though no equivalent of the Magellan *Nothofagus*-beds is known in the Falklands, the latter have yielded Preglacial remains of *Podocarpus*, cf. *salignus* and *Libocedrus*, cf. *chilensis;* and since these species at the present day do not occur on the mainland farther south than the forty-fifth parallel it is probable that shortly before the Glacial period the Falkland climate was warmer than it is to-day. It does not appear probable that the islands were ever extensively forested; indeed, the author considers that the general character of the vegetation has remained unaltered from Preglacial times, and that, though the cold resulted in the killing out of the trees and the establishment of tundra conditions, many species survived the Glacial period, while others (especially the thermophilous forms) were immigrants from the west in Postglacial times, when the climate of Tierra del Fuego was warmer than now. The grazing of sheep and other forms of cultivation have greatly influenced the native vegetation; for instance, the coastal tussock formation of *Poa flabellata* has been largely destroyed.

The climate of the Falklands is more oceanic than that of the neighbouring Tierra del Fuego coast, with more uniform distribution of rainfall through the year; the summer is cooler and the winter milder. The absence of trees is attributable to the strong winds, the configuration of the islands being such that no part is sheltered from the wind. The normal climatic formation is the *Empetrum* heath, but there are also extensive associations dominated by the Umbelliferous cushion plants *Bolax* and *Azorella*, and by the grass *Cortaderia*. The *Empetrum* heath forms a counterpart of the North Atlantic heath in Scotland, the Faroes, and West Norway; the *Bolax* heath resembles the alpine associations in Tierra del Fuego and Kerguelen with *Bolax* and *Azorella* dominant. The *Cortaderia* association also occurs in South Georgia, and in his earlier work on the Falklands the author termed it a steppe, but he now considers that it is better described as a meadow association. The author gives interesting notes on the vegetative characters and the flowering of the various species, with special reference to periodicity, and classifies the plants according to their "biological types." An account of Raunkiaer's "biological types" or "life forms" among plants—one of the most interesting recent contributions to plant ecology—is given by Dr. W. H. Smith in the *Journal of Ecology* (Vol. 1, No. 1, 1913). The most important of the latter are the hemicryptophytes (fifty-five per cent.) and the chamaephytes (thirty-one per cent.), but the author points out that the census hardly supports Raunkiaer's characterisation of the Falkland flora as the expression of a "chamaephyte climate," and that the important point is, not merely the large percentage of chamaephytes and hemicryptophytes, but the fact that both classes are evergreen in the Falklands. Thus, while the flowering of the Falkland plants shows marked periodicity, none flowering in winter, there is very slight vegetative periodicity, since most of the plants are evergreen, and simply show arrest of growth in winter.

CHEMISTRY.

By C. Ainsworth Mitchell, B.A. (Oxon), F.I.C.

THE SOLUBILITY OF CALCIUM CARBONATE.—In a paper read before the Institute of Water Engineers on December 13th, 1913, Mr. W. T. Burgess calls attention to the influence of the solubility of calcium carbonate upon processes in which lime is used for softening water. The bulk of the carbonates of calcium and magnesium, to which the temporary hardness of water is due, is kept in solution by the carbon dioxide which is also present. When the water is boiled the carbon dioxide is expelled and the carbonates are deposited. The same effect is produced

by adding a calculated amount of lime to the water, so as to combine with the carbon dioxide. Mr. Burgess, however, points out that the lime-softening process does not effect the removal of the whole of the calcium carbonate, since water that is quite free from carbon dioxide will dissolve one and a half parts of calcium carbonate per one hundred thousand. Moreover, the separation of the calcium carbonate does not take place so rapidly as is sometimes supposed; for, even where the precipitation appears to be complete, a slow deposition of crystalline calcium carbonate may continue for several days; and the more completely the water is softened the longer the time that should be allowed for subsidence in the tank. Neglect of this precaution may lead to the deposition of calcium carbonate in the mains. To obviate this in cases where it is essential to use the water soon after softening, a small quantity of carbon dioxide may be introduced into the water. As little as 0·3 part of carbon dioxide per one hundred thousand parts of water will prevent this after-precipitation of calcium carbonate in the pipes.

The same difficulty would be likely to occur in using Dr. Houston's process of sterilising water by adding an excess of lime and subsequently removing this excess by the addition of carbon dioxide or sodium bicarbonate. The last portions of the precipitated calcium carbonate would subside so slowly that there would be risk of deposits forming in the water-mains unless a precaution such as that described were taken.

SULPHURETTED HYDROGEN FROM ARTIFICIAL GRAPHITE.—A specimen of the artificial graphite manufactured by Dr. Acheson was found by Messrs. Woodcock and Blount (*Analyst*, 1914, XXXIX, 67) to possess the curious property of emitting sulphuretted hydrogen when broken or scratched with a knife. The material, which was soft and "greasy" to the touch, contained 0·11 per cent. of sulphur and 0·20 per cent. of ash, consisting of silica, aluminium, iron, calcium, and magnesium. The microscopical appearance closely resembled that of ordinary natural graphite, and experiments in which the material was heated in a current of hydrogen proved that the presence of the sulphuretted hydrogen was not due to any occlusion of gas within cavities. Eventually it was found that the gas must have originated from an unstable aluminium sulphide of the type Al_2S_3, which was decomposed by moist air, but was protected from such action until it was exposed by the fracture of the surface of the material.

SOAPS FROM NAPHTHENIC ACIDS.—The increasing demand for fats suitable for manufacture into food-products is leading to many curious developments in the soap industry. Among the more important changes that have taken place is the steady decline in the use of coco-nut oil, which for so long a time has formed the basis of soaps that would produce a good lather and could be used with salt water. Scientific methods of purification have succeeded in removing from this fat the constituents to which it owes its pronounced odour and flavour, and in consequence coco-nut oil has become one of the chief components of margarine, vegetable lard, and butter substitutes. The commercial result has been that very little of the fat is now available for technical purposes, and the price has increased enormously. For example, the crushed coco-nut kernel, or copra, which a year or two ago was sold at £12 per ton, now fetches four times as much, and there seems little chance of its falling again.

Another fat which has hitherto been almost exclusively used for soap is palm oil; but recent improvements in the methods of obtaining the oil have led to the production of a fat sufficiently free from acidity to be used as a food, and it appears probable that before long the demand for edible fats will also absorb this source of supply.

The place of coco-nut oil and palm oils as materials for the manufacture of soaps with good lathering properties has to some extent been taken by soaps prepared from naphthenic acids. These acids are separated as by-products from the waste lyes left in the refining of petroleum oil. They are used as preservatives for wood, as solvents for resins, and as substitutes for turkey-red oil in dyeing; but their principal application, especially in Russia, is in the manufacture of soap.

As naphthenic acids have many physical characters in common with the fatty acids of coco-nut oil and palm-kernel oil they may be used for similar purposes. Thus it has been shown by Dr. Davidsohn (*Zeit. angewandt. Chem.*, 1914, XXVII, 2) that their molecular weights are almost the same. The soda soap requires even more salt than coco-nut or palm kernel oil soaps for separation, the comparative figures being coco-nut oil soap, 13·1; palm-kernel oil soap, 10·9; and naphthenic acid soap, 20·9. It is thus particularly suitable for all purposes where good lathering properties are essential, such as, for example, for use with sea water.

ENGINEERING AND METALLURGICAL.

By T. Stenhouse, B.Sc., A.R.S.M., F.I.C.

NOMENCLATURE OF ALLOYS.—The Committee appointed by the Council of the Institute of Metals to consider the question of the nomenclature of alloys, as raised by Dr. W. Rosenhain, presented its first report to the Annual General Meeting of the Institute, held in March. The difficulties of the problem were fully recognised, and, after much discussion, it was decided that the only principle of sufficiently wide applicability upon which a rational or systematic nomenclature could be based was that of naming alloys according to their chemical composition by weight, the names of the component metals being placed in the order of increasing numerical importance. Thus an alloy containing three per cent. of copper and ninety-seven per cent. of aluminium would be called "copper-aluminium," and one containing ninety-two per cent. of copper and eight per cent. of aluminium would be called "aluminium-copper." With alloys containing more than three metals this principle leads to a considerable degree of cumbrousness, and therefore certain modifications are proposed to overcome this difficulty. Besides establishing this rational system of names, the Committee have approached the task of defining, in its terms, the ordinary names of alloys intended for everyday usage. Thus "brass" is to be used as an abbreviation of the name "zinc-copper," and an alloy containing tin one per cent., zinc twenty-nine per cent., and copper seventy per cent. will be called "tin-brass." Similarly "bronze" is to be used as an abbreviation of the words "tin-copper" as employed in the systematic nomenclature. In the present report the Committee have defined only these two practical alloy names, but they hope in the next report to put forward a considerable number of "practical" names.

THE ESTIMATION OF ZINC IN COINAGE BRONZE BY VOLATILISATION.—In a paper read before the Society of Chemical Industry Dr. T. K. Rose described an extremely interesting old furnace-method of determining zinc in coinage bronze. It was used many years ago at the Royal Mint, but was allowed to pass out of use in 1870, probably because the temperature was often too low to be efficacious. Its origin is unknown. The method consists simply in heating the bronze in a carbon crucible, driving off the zinc by volatilisation, and weighing the residue. The old crucibles are still used. They are made of gas carbon, and are hexagonal prisms outside, about 2·2 centimetres across and 2·2 centimetres in height. A receptacle for the bronze is hollowed out inside, 1·1 centimetre in diameter and 1·5 centimetre deep, and is provided with a closely fitting lid. The crucibles, each containing one gramme of bronze, are placed close together inside a salamander crucible, and completely covered by powdered charcoal. The cover pot is then strongly heated for two hours in an ordinary gas-injector furnace. The final

temperature has been found to be 1375°C., the boiling point of zinc being 905·7°C. Dr. Rose has recently tested the process, and finds it trustworthy and useful, if due precautions are observed. The high temperature is absolutely necessary. Attempts to drive off the zinc in a gas assay-muffle urged to the highest attainable temperature—about 1200° C.—proved unavailing. In two hours in the muffle furnace the loss of weight was insignificant.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

THE NEBULAR HYPOTHESIS.—Students of cosmogony will read with interest an analysis of gravitational instability and the nebular hypothesis by Mr. J. H. Jeans (*Phil. Trans. Roy. Soc.*), Series A, Vol. CCXIII, pp. 457-485. Analyses of rotating astronomical matter have been hitherto based on the assumption that it is homogeneous and incompressible. This condition is purely ideal, for, as the author of the paper remarks, primordial astronomical matter must be extremely heterogeneous and compressible. Density and pressure must vary independently of each other and with variation of temperature and chemical composition. No general theory can be given to cover such conditions, but definite problems may be examined, and, as Mr. Jeans shows, the results of these examinations indicate that the older analyses with their theoretical assumptions supply remarkably correct information and guidance. For the case in which the pressure is a function of the density when there is no rotation and the boundary is spherical he arrives at Laplace's solution:

$$\rho = A_0 r^{-\frac{1}{2}} J_{\frac{1}{2}}(\kappa r) = \frac{A_0}{\sqrt{\frac{1}{2}\pi\kappa}} \frac{\sin \kappa r}{r}.$$

For a solution in the case of small rotation, assumptions not generally admissible are necessary; but the problem of rotating cylindrical masses is found to be amenable to analysis and to be useful. Rotating nearly spherical masses with high internal temperature are also dealt with. The conclusions reached on an admittedly partial discussion are found to be generally in accord with those of the earlier investigators. Slow rotation gives flattened configurations similar to those of Maclaurin's spheroids passing into forms like the ellipsoids of Jacobi.

SEISMOLOGY.—In the *Comptes Rendus*, Vol. CLVIII, No. 6 (9th Feb., 1914), M. de Montessas de Ballore discusses the results of modern seismology. In the eleven years, 1899-1909, eight hundred and eighty-one megaseisms were registered by means of horizontal pendulums at fifty-nine observatories, and the results were very homogeneous. The number of more or less destructive earthquakes, that is, of megaseisms directly observable on land, is thirty-one, or one-third of the mean number occurring annually. This is in accord with the ratio of land to sea, and the inference is that submarine tremors are about as frequent as terrestrial. Milne states that thirty thousand sensible shocks occur every year: a thousand times as many as destructive earthquakes. For the whole surface of the globe the annual number of appreciable tremors is eighty thousand. The Pacific, between 120° E. and 60° W., that is, the water hemisphere, encloses 80% of the epicentres: 42% in the west and 35% in the east. These are the two most important seismic areas of the globe. So far as the relief of the ocean bed is known, the same relation is recognised between it and earthquakes as holds on land. In both cases the degree of seismicity corresponds with the geologic history. It may be noted that seismic conditions in the coral seas seem to this author to be in opposition to the Darwinian theory of the formation of coral reefs.

IS THE EARTH DRYING UP?—Professor J. W. Gregory discussed this question at the meeting of the Royal Geographical Society on December 13th last (*Geog. Journ.*, Feb.—Mar., 1914). He enumerates three forms of the Desiccation Theory. Prince Kropotkin holds that the data indicate a steady progress in the climate towards drought, with possible fluctuations in the advance. Professor Ellsworth Huntingdon's view is that there is alternating desiccation and humidification sufficient to produce profound changes in the political and economic situation, but that the resultant tendency is towards drought. The third form is that there are long climatic cycles, and that the Earth is now approaching a maximum of cold and dryness which it should reach, according to Mr. R. Thirlmere, about A.D. 2300. Professor Gregory's examination of the vast collection of evidence leads him to the conclusion that there has been no general and profound climatic change within the historic period comparable to the widespread changes which undoubtedly occurred in late geological times. The change from the climate of the Glacial period, he believes, took place mainly in two ways. In some parts the temperature has risen gradually and the humidity increased or decreased; in others the period immediately post-Glacial was warm and dry, but the humidity gradually increased. The latter has been the mode of change in Scandinavia, Germany, Hungary, Rumania, the south and east of North America, parts of Africa from Nigeria to Cape Colony, and possibly in England. For the desiccation of Asia there seems to be as much weight of evidence as against. Professor Gregory suggests that the explanation may appear when the Eurasian continent is taken as a whole. In Asia the desert is increasing in some parts and contracting in others, while a counterpart to the decrease in total rainfall over Asia is found in its increase in Europe. "Variations in the distribution of rainfall must result from any considerable alteration in the level of the land; the uplift of a continent must cause the rainfall to become heavier on the margins and lighter in the interior. The increase of rain on the coast lands would, however, hasten their lowering by denudation, and again the rain would sweep over the interior; hence that marvellous geographical equilibrium which has rendered possible the unbroken course of evolution would in time, unless checked by renewed uplifts of the coast lands, restore the more even distribution of the rain and revive the desolate regions in the heart of a continent."

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

THE RÔLE OF WATER IN VOLCANIC ACTIVITY.—The views of Brün (discussed in "KNOWLEDGE," September, 1911, p. 352), that volcanic eruptions are essentially anhydrous, receive emphatic refutation in a paper, by Day and Shepherd, on "Water and Volcanic Activity" (*Bulletin of the Geological Society of America*, Vol. XXIV, 1913). This work is based on the study of gases collected from the volcano of Kilauea in pursuance of an extended scheme of study promoted by the Geophysical Laboratory of Washington. Much of Brün's argument depends on the observation that dewpoint readings taken inside the white cloud emitted from the volcano are actually less than those taken in the clear air outside. Day and Shepherd show that the cloud is composed of minutely divided particles of sulphur (not crystalline chlorides, as supposed by Brün), around which water may condense. Furthermore, the partial oxidation of the sulphur would produce the dioxide and trioxide, both of which are effective drying agents. It is therefore "a matter of grave doubt whether the readings of a dewpoint hygrometer in an atmosphere containing SO_2 and SO_3 have any significance whatever in view of the well-known affinity of these compounds for water." Successful attempts were made by Day and Shepherd to collect the volcano gases before they had reached the air. In the first attempt no less than three hundred c.c. of water accumulated in collecting tubes of ten litres capacity. Although, owing to the

method of collection, this does not represent the proportion of water to the total quantity of volatile matter discharged from the volcano, it proves beyond doubt that these gases contain original water. Analyses of the gases collected shows that the Halemaumau crater yields nitrogen, water-vapour, carbon dioxide, carbon monoxide, sulphur dioxide, free hydrogen, free sulphur, with chlorine, fluorine, and perhaps ammonia, in comparatively insignificant quantity. After the most critical examination the nitrogen was found to be free from argon and other rare gases. This affords a good proof that the volcano gases were collected before contact with air, and that volcanic nitrogen is not of atmospheric origin.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

RAINFALL AT NOTTINGHAM.—A very elaborate and valuable report, entitled "The Meteorology of Nottingham," is prepared annually by Mr. A. Brown and Dr. Boobbyer. In the last report they give a table of the rainfall for the past forty-seven years, 1867 to 1913. The values, which are very instructive, are as follows:—

Year.	Rain-fall.	Year.	Rain-fall.	Year.	Rain-fall.	Year.	Rain-fall.
	in.		in.		in.		in.
1867	**29·90**	1879	**27·31**	1891	**25·89**	1903	**32·37**
1868	**25·33**	1880	**35·45**	1892	*21·58*	1904	*19·73*
1869	**27·75**	1881	**27·49**	1893	*20·17*	1905	*20·01*
1870	*17·93*	1882	**34·38**	1894	*20·25*	1906	*23·94*
1871	**26·83**	1883	**30·05**	1895	*20·75*	1907	**25·65**
1872	**35·90**	1884	*20·10*	1896	*22·99*	1908	*22·70*
1873	*20·51*	1885	**26·66**	1897	*23·73*	1909	**26·05**
1874	*18·11*	1886	**31·76**	1898	*19·75*	1910	**26·55**
1875	**31·71**	1887	*15·64*	1899	*22·64*	1911	*19·79*
1876	**29·31**	1888	*19·99*	1900	**28·53**	1912	**31·14**
1877	**28·77**	1889	**25·61**	1901	*20·11*	1913	*22·46*
1878	**28·84**	1890	*17·70*	1902	*21·52*	—	—
Mean	26·74		26·01		22·35		24·58

The greatest rainfall was 35·90 in. in 1872, and the least 15·64 in. in 1887, the average rainfall for the whole period being 24·93 in.

By printing the values in two kinds of type, those in thick type being above the average and those in italic being below the average, it will be seen that during the first half of the period there were only seven instances with the rainfall *below* the average, while during the second half there were only seven instances with the rainfall *above* the average. Another important feature brought out by the figures is that the mean rainfall for the first half of the period (twenty-four years) is 26·38 in., while the mean for the second half of the period (twenty-three years) is only 23·42 in., a difference of 2·96 in.

This brings out very strongly the absolute necessity for reliable averages of rainfall to be based on a long period of observation, otherwise an entirely misleading result may be obtained, and this may lead to disastrous consequences if the water supply of a town be dependent on the same.

The late Mr. G. J. Symons, F.R.S., arrived at the following conclusions with regard to limited fluctuations in the yearly rainfall: (1) The wettest year will have a rainfall nearly half as much as the average; (2) the driest year will have one-third less than the average; (3) the driest two consecutive years will each have one-quarter less than the average; and (4) the driest three consecutive years will each have one-fifth less than the average.

THE GREAT HEAT AND DROUGHT OF LAST SUMMER IN THE UNITED STATES.—Mr. P. C. Day has given in the *Monthly Weather Review* for September, 1913, an account of the intense heat and drought which prevailed last summer over a large portion of the United States. From this we learn that about the middle of June unusually warm weather set in over nearly all portions of the country to the eastward of the Rocky Mountains, with the centre of greatest temperature excess above the normal in the middle portions of the Great Plains and Mississippi Valley. With but slight interruptions, this unusually heated condition continued over these districts and adjacent regions until near the end of the first decade of September. During this entire period of about twelve weeks of almost continuous excess of heat, dry weather also prevailed in the same region with more or less severity, which, with almost continuous sunshine, frequent hot winds, and deficient humidity, combined to produce one of the most disastrous seasons in the history of the region affected.

The month of August, as a whole, was one of the warmest ever known in the middle West, the heat exceeding in some of the States that of July, 1901, which has generally been accepted as the warmest month ever known in the United States, save in the desert regions of the South-West. In Kansas the average maximum temperature in July, 1901, was 100°·9, while for August, 1913, it was 101°·5. Notwithstanding this increase in the day temperature, the nights were cooler than those in July, 1901, the average minimum temperatures being in July, 1901, 69°·3, and in August, 1913, 67°·3, a difference of 2°. The average daily range was therefore 2°·6 greater during August, 1913, than during July, 1901. The highest temperature registered during the period was 116° at Farnsworth, Kansas, on July 11th, and several stations reported as high as 113° in both July and August. The station reporting the highest mean maximum temperature was Clay Centre, Kansas—107° for August—a record doubtless never exceeded in the United States, save only at a few of the hottest points in the desert valleys of South-Western Arizona and Southern California. At the above mentioned point in Kansas the maximum temperatures were 100° or higher each day from August 1st to September 7th inclusive, save for one day, when it rose only to 92°, the average for the period of thirty-eight days being 106°·5, while the total number of days with maximum temperature 100° or above from June 16th to September 7th was 64.

At the same point from July 1st to September 8th, a period of seventy days, the precipitation was but 0·03 inch, a record likewise unsurpassed for the principal crop-growing season in the history of the State. Wells and springs dried up that had never previously failed, and streams were in many cases the lowest on record, the observer at Ottawa, Kansas, reporting the river at that place as being the lowest in a period of fifty-three years.

PILOT BALLOON ASCENTS AT UPAVON DURING 1913.—At the Meeting of the Royal Meteorological Society on February 18th Mr. G. M. B. Dobson read a paper on "Pilot Balloon Ascents at the Central Flying School, Upavon, Wilts, during the year 1913." These balloon ascents are made with the object of obtaining information which will be of use for pilots in flying. The results given in the paper were based upon ninety-seven ascents. It was found that the direction of the wind veers from, and its velocity increases with, increasing height above the ground until the gradient direction and gradient velocity are reached. The gradient velocity is usually reached at a height of one thousand feet, though the gradient direction is not found until a height of about two thousand five hundred feet. At higher altitudes the velocity tends to increase and the direction continues to veer slightly beyond the gradient velocity and direction. Light winds show little increase of velocity with height, and they do not seem to have quite reached the gradient velocity below

three thousand three hundred feet. Moderate winds attain the gradient velocity at one thousand feet, but strong winds at one thousand six hundred and fifty feet. The increase of velocity is greater for strong than for moderate winds. The increase of velocity with height is much more rapid in the morning than in the middle day, and the increase is greater in spring than in summer. At those times when the velocity increases rapidly with height above the surface the direction also veers comparatively rapidly, and *vice versa*.

The majority of the ascents were followed by one theodolite only, as twice the amount of time would be required for working out the results if two theodolites were used.

WEATHER MAP OF THE NORTHERN HEMISPHERE.—With the commencement of this year the United States Weather Bureau has begun the publication at Washington of a weather map of the Northern Hemisphere, which is to be printed on the reverse side of the morning weather map of the United States. Although the number of reports available for the construction of the map is necessarily very limited and the times of observation are not all strictly synchronous, nevertheless the essential features of the atmospheric circulation over the Northern Hemisphere are fairly well depicted. The publication of these maps will tend to facilitate and promote the serious scientific study of the great and complex problems of the general circulation of the atmosphere.

On these maps the C.G.S. (centimetre-gramme-second) units are exclusively used, the barometric pressures being given in millibars (1000 millibars = 29·531 inches) and the temperatures on the absolute scale (centigrade), on which the temperature of melting ice is 273°.

The English Meteorological Office has also since the commencement of this year employed these units on the maps given in the *Weekly Weather Report*. It is greatly to be regretted that the ordinary English values are not also given on both these maps, as the vast majority of persons do not know what a millibar is, and probably have never heard of the term. The best method of paving the way for the introduction of the new units would be always to give the corresponding ordinary English values at one end of the isobars and isotherms, and the C.G.S. values at the other end. By this means the equivalents of each scale would soon become known.

MICROSCOPY.

By F.R.M.S.

A NEW ZEISS OBJECTIVE.—In examining blood films we want to know—

(*a*) The relative numbers of the normal types of leucocyte.

(*b*) Whether any abnormal corpuscles are present.

(*c*) Whether any organisms of pathological import are present outside or inside the corpuscles.

As already stated (page 33 of present volume), we can ascertain (*a*) with a fairly low power provided the illumination is good. In order to be sure about (*b*) and (*c*) it is generally desirable to use an oil-immersion lens. I suggested that a $\frac{1}{7}''$ immersion might be better than a $\frac{1}{12}''$, because of the larger field. Messrs. Zeiss have now produced such an objective. Its N.A. is 0·9, free working distance 0·35 mm., diameter of field of view with Huygenian ocular 2, 0·42 mm. The corrections are equal to those of the ordinary immersion twelfth by the same makers. On examination we find that this objective gives an exceptionally brilliant image—slightly better, in fact, than that yielded by the very best dry lenses when perfectly corrected—the explanation being found in the abolition of the reflecting surfaces. The superiority in brilliance is so marked as to convince anyone that his medium-power objective ought to be an oil immersion. As to definition, the new lens gives surprisingly good detail with the highest oculars. When tested upon coloured objects it is seen not to be apochromatic, but it is the equal of the best achromats. For the purpose of haematology its large field, suitability for use with uncovered preparations, and depth of focus make it quite the ideal objective. The large field enables a differential count to be made in about half the time: the long working distance makes it extremely improbable that the front lens will be injured if ordinary care be used. It gives good photographic results with a screen and panchromatic plate. It can be used successfully for dark-ground illumination. For all ordinary diagnostic purposes it is an efficient medium and high power combined.

E. W. B.

GROUND GLASS LABELS.—With reference to the note in the January issue of "KNOWLEDGE" (page 32), it may be worth mention that carborundum powder will produce a ground surface more quickly than emery. The powder may be purchased at most tool-shops, and costs 1/2 per pound. The FFF grade is the finest, and is most suitable. The same method may be used to produce fine-grained focusing screens for photographic cameras.

H. H. P.

QUEKETT MICROSCOPICAL CLUB.—At the 48th annual general meeting of the Quekett Microscopical Club, held on February 24th, the presidential address was delivered by Professor A. Dendy, D.Sc., F.R.S., who spoke on "Organisms and Origins." An account was first given of the theories current in the early part of the 18th century, explaining the nature and origin of fossils, with especial reference to a "Physico-Theological Discourse," by John Ray, published in 1732. This deals with the occurrence and origin of fossils, which are attributed to the waters of the universal Deluge, "bringing up out of the sea and scattering all the Earth over an innumerable multitude of shells." A friend of Ray's, Edward Lhwyd, M.A., F.R.S., suggested that a *seminium* may be raised with the exhalations from the sea, and falling with the rains and fogs may penetrate the "Chinks and Meatus's" of the Earth and there develop and eventually be petrified.

There are only two possibilities with regard to the origin of terrestrial organisms. Either they must have been imported from some other planet in the form of germs, or they must have developed on the Earth's surface from inorganic materials that formed part of the Earth itself. The theory of Panspermia, due to Arrhenius, was mentioned, and while it was thought possible that the minute germs there postulated might be able to resist the cold of interplanetary space, the fatal effects of the ultra-violet radiations from the Sun would be a most serious objection. Reference was made to the Chlamydozoa, or "filter-passers," organisms so minute as to be beyond the reach even of ultra-microscopic methods, and which certainly have a smaller diameter than 0·000001 millimetre. Yet these organisms are believed to be the cause of certain diseases such as yellow-fever, cattle-plague, rabies, and others. That these diseases *are* due to living organisms, and not to lifeless toxins, is indicated by the fact that a period of incubation always follows infection.

Dealing with spontaneous generation, mention was made of the classical experiments of Pasteur, Tyndall, and others. An account was then given of the recently published work of Dr. Charlton Bastian, who for some of his positive results employed a very dilute solution of pure colloidal silica with the addition of either pernitrate of iron or phosphoric acid and ammonium phosphate. Torulae, bacteria, and even moulds have apparently developed in this observer's tubes in varying quantities. The President said that to a certain extent these results are in accord with purely *a priori* expectations, but in other respects they appear improbable to the last degree. Most of the organisms produced are of well-known types, and one of the moulds formed appears to be a *Penicillium*, producing spores in the ordinary way. It was impossible to believe that such comparatively highly organised beings can have been evolved so rapidly from ultra-microscopic germs. Altogether we may fairly say that the acceptance of Dr.

Bastian's results would involve us in so many difficulties that it is preferable at present to believe that there has been some error in his mode of procedure, some unexpected loophole through which contamination of his preparations has taken place.

THE CLEANING OF POLYCISTINOUS EARTH.—In the second number of *The Journal of Micrology* the question of cleaning polycistinous earth is discussed by Mr. Thomas E. Doeg. His method is to put small lumps of the material into a boiling-hot solution of acetate of soda. The mixture is then boiled and allowed to crystallise. This process is repeated several times until the lumps are disintegrated to form a muddy deposit. The soda is then got rid of by washing, and any lime and some of the organic matter which is present are removed by boiling in nitric acid. Then there is more washing and another boiling, this time in strong sulphuric acid, to which a small pinch of powdered chlorate of potash is added, from time to time, with great care, and the fumes allowed to pass away up a chimney. The work is not done then. The material must be thoroughly washed again, boiled in a fairly strong solution of soapy water, and finally washed with hot distilled water. Mr. Doeg says that if the material be refractory the whole process may have to be repeated two or even three times.

PHOTOGRAPHY.

By Edgar Senior.

RESTORING TARNISHED DAGUERREOTYPES.—The great number of years which have now passed since the days of the Daguerreotype process has resulted in many of those fine examples of photography becoming more or less marred through the formation of a metallic-looking veil or film, which greatly obscures the image. That this veil may be successfully removed without injury to the picture does not appear to be generally known; and, although the operation is a delicate one, requiring great care, it will, when properly carried out, practically restore the photograph to its original condition. It would not be wise, however, for a novice to practise on a valuable specimen at first; and in no case must anything that is a solvent of finely divided silver or mercury be used, or injury to the image will result; hence cyanide of potassium should be carefully avoided. The best agent for the purpose appears to be pure hydrochloric acid, free most especially from any trace of nitric acid. The Daguerreotype being carefully levelled, a little of the acid is poured over it, when the tarnish will be quickly removed and the image appear bright and clean. Directly this appearance is evident the acid must be washed off under a stream of water from the tap, and the plate finally rinsed well in several changes of pure distilled water. The final operation is the drying of the plate, and this requires to be carefully done in order to avoid markings being apparent on the surface when finished. The operation is carried out by holding the plate by means of a pair of pliers over the flame of a bunsen burner or a spirit lamp, heating one corner rather more than the rest, and then holding the plate in a nearly vertical position with the hottest part at the top. The surface is blown upon in order to ensure rapid and even evaporation of the water. Lastly the restored Daguerreotype should have a glass placed over it, and the whole bound round with strips of paper to exclude the air as much as possible from entering.

THE RAPID DRYING OF NEGATIVES.—Negatives taken on gelatine plates are at a disadvantage compared with those made by the older collodion process with regard to the length of time the former take to dry, whereas a collodion film may be dried in the space of a few minutes by the aid of heat: any attempt to do so in the case of gelatine would be met with fatal results. Any method, therefore, which will with safety accelerate drying becomes at times very welcome. Although high temperature favours rapid evaporation of water, this alone is not of much good without ventilation, for, as air may be saturated at any temperature below that of boiling water, it is necessary that such air be constantly removed and replaced by drier air in order to carry off the moisture, and the higher the temperature of the air the greater the quantity of water it is capable of taking up before becoming saturated. Then, again, the temperature at which the drying takes place should be kept as constant as possible, since any great variation is almost certain to result in patches of uneven density in the negative. Further, the surface water on the film should evaporate evenly, otherwise patches showing a difference in density will be apparent. A defect of this kind is frequently seen in spots about the size of a pea, the film still remaining swollen in these parts when the rest of the plate is practically dry. Trouble of this sort may, however, be avoided by removing the surface water with a piece of cotton-wool, or pressing the palm of the hand, or a soft squeegee over the film, and then gently blotting with soft fluffless blotting paper. Whirling the plate is also to be recommended, as then the surface water is quickly thrown off and the film becomes almost surface-dry in a very short time. Or, better still, place the plate in a bath of alcohol for a few minutes and then whirl, and if two alcohol baths be employed the drying will be greatly accelerated. Negatives that have been soaked, "after removal from the washing tank," in a saturated solution of common alum or in chrome alum can also be dried more rapidly, since, the film having become much harder, a higher temperature can be employed in drying. Then, again, if the negative, be immersed in a ten per cent. solution of formalin for about five minutes the film becomes so hardened that it will bear drying by a fire even without injury. It has also been recommended to add the formalin to the "hypo" bath in order to attain the same end, although personally we prefer to use it after fixing and washing. A consideration of the question of drying formed the subject of a paper read before the French Photographic Society some time back by Messrs. A. and L. Lumière and A. Seyewetz, in which the authors described the use of strong solutions of iodides, chlorides, bromides, as well as nitrates, chlorates, and carbonates as desiccating agents. They further showed that sulphate of aluminium as well as zinc sulphate exerted most complete drying action, and, further, that ammonium sulphite, soda sulphite, and "hypo" behave in the same way. Of the various substances experimented with, however, that in which a cold saturated solution of potassium carbonate was employed was found to give the best results. The affinity of potassium carbonate for water is well known, a method of estimating the amount of water in alcohol being based upon it. When sulphate of aluminium was the substance employed they recommended a one hundred per cent. solution, while in the case of zinc sulphate a one hundred and sixty per cent. was the strength given, while with "hypo" a one hundred per cent. solution was found necessary. In the case of potassium carbonate the following was the formula :—

Potassium carbonate (dry)	90 grams.
Water	100 c.c.

The negative to be treated requires to be immersed in the solution from four to five minutes, after which it is blotted between blotting paper, when the drying is further completed by wiping the surface of the film with cotton-wool or a soft cloth.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A., LL.D.

SPONGES IN WATERWORKS.—Professor W. N. Parker discusses the extensive growth of *Spongilla lacustris* in the pipes leading to one of the filter-beds of the Cardiff Waterworks. Some of the branches were eight inches long, and in mid-winter the sponge showed no trace of dying down. It can grow as well in the dark, without zoöchlorellae, as in the light. No trace of larvae or sexual reproduction was seen throughout the year; the production of gemmules

is more than sufficient. Professor Parker recommended that the pipes and chambers should be scraped and treated with strong brine, and this method has been very successful in getting rid of the sponge.

COMPETITION BETWEEN PORTUGUESE OYSTERS AND COMMON OYSTERS.—J. L. Dantan reports that at Arcachon the Portuguese oyster (*Gryphea angulata*) is steadily predominating over the common oyster (*Ostrea edulis*)—a very undesirable victory so far as the fishery is concerned. The Portuguese form is not viviparous like the other, and there is probably even greater mortality in the early stages; but after fixation has been effected the shells grow very rapidly and smother adjacent common oysters.

CETACEAN PELVIC BONES.—To those with some imagination it is impressive to see the pelvic bones of a big Cetacean. Dwindling relics they are of originally large hip-girdles. Sometimes there are remains of a femur and tibia as well, but the pelvic bones are connected only with the adjacent muscles (the tail muscle, the genital muscles, and a trunk muscle). Willy Augustin has recently studied a considerable number of specimens of the pelvis of *Balaenoptera physalus* (the Finner), *B. sibbaldi* (the Blue Whale), *B. borealis* (Rudolphi's Rorqual), and *Megaptera* (the Humpback), and taken very careful measurements. He shows that these vestigial bones are, like many vestigial structures, in a condition of variability. He regards each pelvic bone as equivalent to ischium only. Röntgen photographs showed that the characteristic internal architecture of the bones was still intact.

MEASUREMENT OF INTENSITY OF INBREEDING.—Dr. Raymond Pearl explains in Bulletin No. 215 of the Maine Agricultural Experiment Station (1913) a formula for measuring the degree of inbreeding. The inbred individual possesses fewer different ancestors in some particular generation or generations than the maximum possible number for that generation or for those generations. The measure of the intensity of inbreeding in any generation is the proportionate degree to which the actually existing number of different ancestral individuals fails to reach the maximum possible number. This coëfficient of inbreeding may have any value between zero and one hundred. When there is no breeding of relatives whatever (that is, in the entire absence of inbreeding) its value for each generation is zero. As the intensity of the inbreeding increases the value of the coëfficient rises.

MIGRATION ROUTES.—Palmén, and after him Weismann, advanced, some forty years ago, the hypothesis that the paths which migratory birds follow to-day are the ancient paths by which they extended their range northwards. One of the difficulties is that the spring route is often very different from the autumn route; but it may be answered that secondary divergences may have arisen in the course of time. Sven Ekman has tested the hypothesis recently with reference to *Tringa minuta* (Little Stint), *Totanus fuscus* (Spotted Redshank), and *Limosa lapponica* (Bar-tailed Godwit) in North Scandinavia, and comes to the finding that it does not fit the facts. Yet he thinks it fits the case of geese (*Anser erythropus* and *Anser fabalis*), and that is because the young and the adults fly together. "If a species," he says, "in which old birds and young ones migrate together follows in the course of its migration a route markedly divergent from the north-south direction, and if this divergence cannot be explained by other conditions (such as a similar succession of geographically homogeneous regions), it may be supposed that the migration is persisting along the path of original expansion of range."

CORRESPONDENCE.

HIGH TIDE AT FREEMANTLE

To the Editors of "Knowledge."

Sirs,—Assuming that your correspondent, Mr. Gornold, refers to Freemantle on Southampton Water, surely there *are* two high tides there.

In my boyhood, and up to, say, 1878, I spent every summer holiday at Freemantle, and almost lived upon Southampton Water. Provided the wind did not affect matters, we always relied on the second tide to get our small sailing boat over the mud shallows to its moorings.

We paid little attention to the first ebb, because we knew that presently boats moored in the channel would swing round again, with sterns to the River Test, and that then it was time to make for home.

R. SHEPHERD.

Claughton,
Birkenhead.

HIGH TIDE AT FREEMANTLE.

To the Editors of "Knowledge."

Sirs,—"Moxly's Theory of the Tides," by J. F. Ruthven (J. D. Potter, 145, Minories; about 1/-), Chapter IX, page 80, appears to be the best article on the subject.

Southsea.

JOHN A. RUPERT-JONES,
Lieut., R.N.R.

CO-OPERATIVE PRODUCTION AND PROFIT SHARING.

To the Editors of "Knowledge."

Sirs,—In the Supplement to *The New Statesman* of February 14th, "Co-operative Production and Profit Sharing," occurs the following:—

". . . the case of the independent producer who works by himself with his own tools on material which he either extracts from the earth or purchases from others, the whole product thus remaining his own property, until he exchanges it for some equivalent received by him. Here we seem to have, in its fullest manifestation, the worker his own master, free from subjection to any man, *enjoying the whole product of his labour.*"

It would be interesting to know the opinion of your economic readers upon the last (and most important) part of this sentence, and which I have italicised.

I am totally at variance with it. Let us take the simplest case where the man works under the conditions indicated, and by the exchange of his produce achieves a standard of living, neither high nor low, but about what is indicated by the productive efficiency of the community in which he lives. He will then be in receipt of nothing answering to the description of "rent" or "profit" (considered as a clear surplus—Mr. J. A. Hobson's "unproductive surplus"). But how will he manage his exchanges? Everything he buys will come to him with the price loaded against him by "profit-cum-rent." Supposing he live in London he will, for instance, buy milk at fourpence per quart. The price *minus* profit and rent is probably about twopence halfpenny. How can he be said to be "enjoying the whole product of his labour," and so on, "in its fullest manifestation"? So far as the illustration serves, he is receiving, not the whole, but merely five-eighths of his product, and he will be in the same case with almost the whole of his expenditure.

G. T. JOLLAND.

60, Gleneagle Road,
Streatham, S.W.

MUSEUMS AND EDUCATION.

By WILFRED MARK WEBB, F.L.S.

(*Continued from page* 91.)

HITHERTO we have spoken in general terms of the contents of a Children's Museum; now we may say something about the specimens which are actually offered as suggestions at the Children's Welfare Exhibition, and their display. The exigencies of time and space have put a very strict limit on what can be shown, and therefore the exhibits will be confined to natural history, chiefly zoölogy. Animals generally attract more attention than plants.

THE LIVING SIDE.—(1) ANIMALS.

As it is hoped that much of what will be on view will be helpful to teachers wishful to have a school museum, an endeavour has been made throughout to choose fittings and apparatus which can be obtained for a small sum of money. For instance, large aquaria and vivaria, specially constructed, are expensive things to buy. On the other hand, square glass boxes, used for storage batteries, are very convenient, if one is content to choose animals suitable for habitations measuring some twelve inches by fourteen inches, and thirteen inches high. This is the size which we have generally used, though somewhat longer ones can be procured.

In the freshwater aquarium the object is to arrange a permanent community, that is to say, a collection of plants and animals so chosen that the amount of carbonic acid gas given off as a result of the breathing of the animals shall be sufficient to provide the plants with this part of their food; while the amount of superfluous oxygen excreted by the plants, when using the carbon to build up starch, shall be enough to supply the animals with what they want for breathing. If a proper balance is established there will be no need to change the water, provided that it does not become foul for any reason.

In the case of marine aquaria, especially in such small ones as have been indicated, it is not so easy to arrange matters. Water in rock pools is changed at each tide, and for the successful conduct of the aquaria it is necessary to provide some artificial means of aëration. Often, a hand-syringe, plied from time to time, will be found sufficient. In some museums, which make a feature of their living side, an air-pump is kept continually at work. This, however, requires an initial outlay of eight or ten pounds, and water or electric power must be provided to keep the pump working.

The apparatus which we have considered more suitable in the present instance is a modification of a very simple contrivance in which, by the continual dropping of water through a tube from one receptacle to another, a flow of air is forced out of the latter into the aquarium. All that is required is two large jars, some glass and india-rubber tubing, some corks, a pinch-cock, a lamp chimney, a wooden tap, and a piece of cane. No continual supply of water is necessary, as that which is put into the apparatus is used over and over again. The labour which is involved consists of drawing off the water from the lower jar and transferring it to the higher one. Where there is a series of jars the addition of a trough, into which the water is discharged from all the lower jars, and an inexpensive semi-rotary hand-pump, which can be connected in turn with the upper row of jars, will render the work much easier.

Turning now to the members of the various groups and classes of the animal kingdom, which may be represented in the living side of the Children's Museum and kept in the receptacles which we have described, we come, first of all, to the Mammals.

MAMMALS.—The class may be illustrated by means of the harvest mouse, the tiny species added to the British fauna by Gilbert White. If some stalks of wheat are fixed into a board at the bottom of the glass box, the mice will climb these slender supports, and, sometimes, construct a nest between them. If these mice are not available others may be used, or one of the voles.

BIRDS.—For birds we shall not be able to use the glass vivaria. As there is no opportunity for caged birds to fly, except in large aviaries, many people do not care to keep them in captivity, though there can be little objection taken to canaries which have been bred in captivity for many generations. A suggestion is made that observatory nesting boxes should be fixed inside the Museum, so that they can be looked into from within, while the birds enter from an opening outside. If such boxes are occupied, not only can the nest and eggs be examined, but the birds actually watched while they are building.

REPTILES.—A goodly number of snakes, lizards, and tortoises can be kept quite satisfactorily in captivity. It is well to show indigenous species of the first two kinds, and some of the smaller and less known tortoises from abroad. The green lizards from the Channel Islands and the Continent, being larger, would want a more extensive enclosure; but there are plenty of smaller foreign species that are imported from time to time into this country.

We ought not to forget the blindworm, an English legless lizard, which soon gets accustomed to being handled.

Amphibians.—For forms which retain their gills we shall have to go abroad. The olm, from the caves of South Europe, lives well in captivity, as does also the American axolotl. This form, though it breeds regularly as a gilled water form, on occasion becomes a land animal, and develops lungs, like the newt. Interesting experiments may be instituted in the Museum to ascertain whether, by gradually restricting the amount of water, axolotls may be induced to make the change. The British newts, like the toads and frogs, go back to the water in the springtime to lay their eggs, but remain there for a longer period. They will be inmates of the aquarium for part of the year.

Frogs and toads will feed well, and become very tame in captivity. The edible frog, which is found in this country, and the natterjack toad will probably be more interesting for exhibition purposes than the common species. There is quite a number of foreign species, too, of small size—tree-frogs and fire-bellied toads—which can be shown.

The land salamanders, which do not need to go to the water, as they produce their young alive, should also be mentioned.

Fishes.—These will be represented, as a rule, by bony fish, and there are plenty of quite small species which can be kept in the battery boxes: the English minnow and stickleback (this latter will, if care be taken to keep a single pair isolated, make its nest and rear its young successfully in aquaria); the bitterling, which lays its eggs in mussel-shells; the umbre, and a number of others. A small pike is interesting, but a larger aquarium will be required. There are also a number of marine fishes which will flourish in aquaria for a considerable time, but here, again, there must be plenty of space at their disposal.

Molluscs.—Examples of bivalves, in the shape of freshwater mussels, of water-breeding univalves, with an operculum or a lid to their shells, such as the freshwater whelks (*Vivipara*), and many of the air-breathing pond snails are common inmates of aquaria. It may here be said that museum jars with flat sides and small battery jars may be used for specimens of one kind of small animal; for instance, freshwater limpets and quite a number of freshwater molluscs can be satisfactorily exhibited in this way.

Molluscoidea.—Lamp shells, being rare marine forms, will not be represented. Colonies of polyzoa are large enough, of course, to be seen in freshwater or marine aquaria, but the individual polyps will only show their full beauty under the microscope.

Arthropods.—Three air-breathing classes of this group can easily be represented—the spiders by the well-known water form, which builds a silken bell below the water, which it fills with air, and in which it lays its eggs. There are many freshwater mites, numerous water-beetles and water-bugs, with a host of larvae of land insects, which pass their early stages in the water. In most cases these are best exhibited in quite small tanks. Where dragon-fly larvae are kept, it is well to have a canopy (with glass on one side and muslin for the roof and the other three sides) over the aquarium. There should also be some sticks or weeds standing above the surface of the water, which will enable the larvae, when it is time for them to change, to crawl up on to the muslin, where the process of the emergence of the dragon-fly can be watched through the glass. Many insects, however, can be kept and reared in vivaria and breeding-cages. An observatory hive is always a source of interest in a Museum, where a suitable place for it could be found. Ants' nests, which can be easily kept between plates of glass, must also not be forgotten; and, going abroad for the moment for material, the ant-lion's pitfall in the sand is calculated to arouse much interest.

The water-breathing division, or crustacea, though chiefly living in the sea, has many freshwater representatives. In marine aquaria we may keep prawns and shrimps, and some of the crabs; in the others, freshwater crayfish, the water-louse, and the fairy shrimp; while many of the water-fleas are large enough to be distinguished.

Worms.—Of the higher worms the leeches live in fresh water, and there are other segmented forms. An attempt should be made to keep some of the tube worms in sea water.

It may here be said that microscopes should be provided in a School Museum, to show the smaller forms of life. Mites and water-fleas, already mentioned, could be demonstrated as well as the rotifers, or wheel-animalcules; some also of the thread-worms, and other lower forms.

The Starfishes and Sea-urchins.—There are no freshwater examples of these forms, but starfishes have been known to live in marine aquaria for some considerable time.

Coelenterates.—Although the little freshwater hydra can just be seen with the naked eye, and is a good microscopic object, it is possible to represent this group very satisfactorily in salt water by means of very beautiful sea-anemones.

Sponges.—Some of the smaller marine sponges should be kept, though the freshwater ones seem to prefer running water.

Protozoa.—Unicellular animals, though they occur in aquaria, will not, as a rule, be visible, except under a microscope.

(2) Plants.

Certain plants will necessarily be used in the aquaria, and some attempt of classification may be made; but in connection with flowering plants

a useful part of this living side of the Museum is a wild-flower table on which the various plants in flower during the week or month are always on view. Seedlings make a good exhibit in their season, and it should not be difficult to show living examples of flowerless plants illustrating the chief groups and classes.

PRESERVED SPECIMENS.—(1) ZOOLOGY.

There is, of course, an almost inexhaustible amount of material of which educational use may be made. It is only possible here to work out a few ideas. Bearing in mind, too, the question of expense, nothing that needs large cases has been introduced. Wall frames built up on the unit system (each containing six glass-topped boxes) have been used to illustrate certain points. Below the frames, on a shelf in some instances, specimens which may be handled have been put.

It is only intended to show the sort of thing that can be adapted to this method of treatment, and no attempt has been made to illustrate the complete contents of a museum. It is suggested that only a certain amount of material available should be displayed at one time, and an excellent use can be made of what is not being shown by sending it round as a travelling museum when it is not wanted at headquarters.

MAN.—It is always well to bear in mind that man is an animal, and the first three cases suggested, bring out some important ways in which he differs from other members of the kingdom to which he belongs. Specimens in these illustrate man as a tool-maker, as the only fire-making animal, and as a worker generally. The implements give an idea of the stages of culture, and a simple industry, such as straw-plaiting, illustrated in the third case, leads on to what might be a folk side to the Children's Museum.

MAMMALS.—Structure, and the classification which is based upon it, may be shown by the series of specimens under the title "Mammals that Gnaw." Here the beaver's skull is exhibited, with wood gnawed by the animals, as well as nuts opened by mice. For handling purposes one of the logs cut by a beaver is added. A more detailed series is that which shows the growth and structure of elephants' teeth. Features of a class generally are indicated by the hairs, spines, and scales under the title "The Covering of Mammals."

BIRDS.—The modifications of a particular structure throughout a class may be learnt from a collection, say, of beaks, of which quite a small one is put forward. Colours of birds' eggs and series of birds' nests will also illustrate the class as a whole; while another, dealing with the feeding of birds, follows up the same idea, and at the same time shows what results may be obtained, by means of crop contents, broken shells, and owl pellets, from material which at first sight may not look very promising.

Internal structure might be treated in the same way. The two classes illustrated already could have other external organs and habits represented; and the same ideas could be applied in the reptiles, amphibia, and fishes as well as to many of the invertebrate groups, where there are hard parts suitable for preservation. In some, a feature could be made of particular attributes, such as protective colouring. Very beautiful series of specimens could be arranged, illustrating the classification, say, of the mollusca and insects, as well as the life-histories of the latter.

(To be continued.)

REVIEWS.

ARTS.

The History of the Royal Society of Arts.—By SIR HENRY TRUEMAN WOOD. 558 pages. 31 plates. 19 figures. 9-in. × 6-in.

(John Murray. Price 15/- net.)

The Society of Arts has been in existence for nearly one hundred and sixty years, and during that time it has done so much work that it would be impossible to chronicle all that has been accomplished for the benefit of humanity, even if a large number of volumes were devoted to the record. From Sir Henry Trueman Wood's labour of love, which extends to more than five hundred and fifty pages, we may, however, get some idea of its activities: of its origin, of the eminent men connected with it at the beginning, of the way in which it has encouraged art, commerce, science, and manufactures, of the great exhibitions which it promoted, and of the examinations which it has held. As Lord Sanderson says in his preface, it came even to the Council as a revelation that the names of the elder Pitt, Lord North, Lord Rockingham, Lord Bute, and other historic Ministers of the time of George III were enrolled among its earliest members in somewhat uncongenial company with John Wilkes and Woodfall, the printer of the "Letters of Junius"; that Dr. Johnson is believed to have made, at one of its meetings, the only speech which he is known to have delivered on his legs; that Oliver Goldsmith was anxious to offer himself as a candidate for the post of Secretary, but was deterred by the refusal of Garrick to support him; and that the Society's efforts to introduce the bread-fruit tree into the West Indies led to Captain Bligh's expedition, which terminated in the mutiny of the "Bounty" and the colonisation of Pitcairn Island.

Not the least interesting part of the book is that which deals with the officials of the Society. The work which they have done is a tribute to their memory; but the present Secretary and author of the book has much praise for his predecessors, and he is himself to be greatly congratulated on his History of the Society of Arts, which he has written after more than thirty years of office.

W. M. W.

ASTRONOMY.

Milton's Astronomy.—By T. N. ORCHARD. 288 pages. 10 illustrations. $8\frac{1}{2}$-in. × $5\frac{1}{2}$-in.

(Longmans, Green & Co. Price 7/6.)

The author and publishers have produced an almost exhaustive volume upon the astronomical allusions of

England's noble poet, Milton, in "Paradise Lost." All who have the slightest interest in poetry or astronomy should certainly spare the time to read this book, written by a devoted student and critic of Milton's verse.

The book opens with a historical sketch of astronomy in fifty pages, dating from the Akkadian and Chinese races, and ends with the year of the death of Milton, 1674. In the second chapter, also of about fifty pages, the author treats of Milton's cosmology; Milton's use of such expressions as "chaos," "empyrean heaven," "mundane universe," "the Alphonsine system of the ten spheres"—the eighth being that of the stars, the ninth called the Crystalline Sphere, and the tenth the *Primum Mobile*—and the use of the Ptolemaic system as the base of Milton's poetic conceptions. The third chapter, as also the second, contains many quotations of the poet's verse: it goes fully into Milton's astronomical knowledge and his use of the older system instead of the Copernican system (about which at that time there was an embittered controversy) that had not then been generally accepted, though Milton perceived that its truth must prevail. The initial date of Milton's changed ideas of the universe the author puts as 1637-9, when Milton visited the Continent, made the acquaintance of Galileo and learnt the views of the great astronomers, Copernicus and Kepler, and was greatly aided by Galileo's actual observations and researches. Though the great epic was written twenty years later, Milton preferred his verse to be based upon the Ptolemaic system, as the one he had recognised in his earlier years, and as the one that still was almost universally held, and would be better understood in his poem. Many quotations are given as illustrations of Milton's views and uses of the Ptolemaic system, and of such astronomical terms as "meridian," "colure," "constellations," "ecliptic," and so on. An entertaining chapter is given of Milton's visit to Galileo in 1638, and Galileo's evident influence upon Milton's later views on astronomy. Chapters V and VI relate to Milton's frequent use of the seasons, the Sun, Moon, and stars; and the book is concluded with Chapters VII and VIII on Milton's references to familiar celestial objects, as Hesperus (Venus), Pleiades, Galaxy, comets, and meteors, and to descriptive astronomy.

Extensive introduction has been made of modern astronomical facts and discoveries, and their application as bearing upon Milton's allusions. Therefore, as already mentioned, this book should be read and used by all who have poetic fancy and love astronomy and England's great poet.

F. A. B.

BOTANY.

Plant Life in the British Isles.—By A. R. Horwood, F.L.S. 254 pages. 73 illustrations. 8-in. × 5-in.

(J. & A. Churchill. Price 6/6 net.)

Mr. Horwood's museum experience has told him that those who are to-day interested in living things are not content just to know the name of a plant or animal, and the points by which it may be identified, but that they wish to learn how, where, and when it grows. Mr. Horwood therefore takes a number of the better-known orders of British wild plants, illustrates them by means of excellent pictures by several skilled nature-photographers, and, while not neglecting the botanical side of the subject, introduces many points of general interest. In many cases we are told how the plant got its English name and what it is called locally. For instance, the wych elm was used for making chests called wyches, or hueches. In some places the teasel is known as "Venus's Belt," the primrose "Lady's Frills." Then, again, the uses of the plants are given. For instance, gruyère cheese owes its flavour to mellilot, the flowers and seeds of this being bruised and mixed with the curd before it is pressed. The groundsel in former days was employed in Scotland to keep off the evil eye. All these matters go to show that Mr. Horwood is not only thoroughly interested in his subject himself, but knows what will appeal to others. We foresee a cordial reception from the volume in hand, and for the later ones to which it is intended to be introductory.

W. M. W.

The Living Plant: A Description and Interpretation of its Functions and Structure.—By William F. Ganong, Ph.D. 478 pages. 3 coloured plates. 178 figures. 9-in. × 6½-in.

(Constable & Co. Price 15/- net.)

Professor Ganong has tried to write a book which he would have been delighted to read himself when he was a learner, and we think that the way in which he has approached his subject will please those who are still learners. He discusses, first of all, the appeal which the study of plants makes to man; he then deals with that most important attribute of many plants, green coloration, and the work of building up food from inorganic sources in the presence of sunlight. Then we have the various activities shown by a plant considered in detail as they affect the individual. Next the way in which the individual is protected from harm occupies attention, before the question of the continuation of the species is described. Chapters are devoted to evolution, to plant breeding, and to classification. The whole structure of the book and its appearance is attractive, and we feel sure that the object which the author had in view has been satisfactorily accomplished.

W. M. W.

CHEMISTRY.

Underground Waters for Commercial Purposes.—By F. L. Rector, B.Sc., M.D. 98 pages. 8-in. × 5-in.

(Chapman & Hall. Price 4/6 net.)

This is an elementary book which gives a clear account of some of the scientific features in connection with the supply of water for industrial purposes and for municipal and public uses. It deals with the sources and properties of water, springs, and wells, and gives a brief outline of the principles of the chemical and bacteriological examination of water—not full enough for making an analysis, but sufficient to interpret the results. Regarded from the point of view of the manufacturer, the criticism may be made that the book does not deal with many of the problems that will occur. For example, the important question of the methods of softening water is dismissed in half a page, and no attempt is made to discuss the relative merits of the different chemical processes in use. In the bacteriological section there is no description of the effects of storage upon bacteria, or of chemical methods of sterilisation, such as the hypochlorite process, now extensively used in America. The bibliography includes only American authorities, and the list of these is by no means complete. The general reader will find much to interest him in the book, but those who wish to install their own water supplies will need to have recourse to larger manuals for much of their information.

C.A.M.

ENGINEERING.

Applied Mechanics for Engineers. By J. Duncan, Wh.Ex., M.I.Mech.E. 718 pages. 725 illustrations. 9-in. × 6½-in.

(Macmillan & Co. Price 8/6 net.)

The worker in any branch of applied science soon learns the limitations of his laboratory experience when he has to deal with processes on a manufacturing scale. Problems present themselves for solution under quite different conditions from those to which he has previously been accustomed, and it is just at this point that text-books usually fail to afford any help. The author of this handbook fully recognises this, and rightly lays stress upon the importance of acquiring a sound knowledge of principles and

of their application under varying conditions. No text-book can ever be made to obviate all difficulties that may occur, but the student who has mastered Mr. Duncan's book should seldom be at a loss. The first part deals with materials and structures, and includes such subjects as the strength of beams, columns, arches, bridges, springs, earth pressure, and so on, while in the second part, which is concerned with machinery and hydraulics, the various problems that will occur in connection with moving machinery are fully worked out and illustrated by excellent diagrams. Typical exercises to be done by the student in the laboratory are given, including those set in the examination for the B.Sc. (Eng.) of London University and other higher examinations in engineering; and there is an excellent index. No better introduction to the study of applied mechanics could be desired.

C.A.M.

Practical Science for Engineering Students.—By H. Stanley, B.Sc., F.I.C., Lecturer in the Merchant Venturers' College, Bristol. 166 pages. 92 figures. 7-in. × $4\frac{1}{2}$-in.

(Methuen & Co. Price 3/-.)

This book is stated to have been written primarily to suit the needs of evening students, who have passed the very elementary stages, and for those entering on an engineering training proper, who have not gone through a good course of laboratory work. It consists of descriptions of practical experiments in heat, mechanics, magnetism and electricity, and light, with short sections in which theoretical principles are briefly stated. The practical experiments described call for little remark. A final chapter dealing with the nature of some materials commonly found in engineering practice contains some inaccuracies. Thus in the section on iron occur the statements: "The Bessemer process can be stopped at any desired point. If one to two per cent. of carbon is still left, a steel is formed; but if only about 0·5 or one per cent. of carbon is left, ingot iron—a species of wrought iron or mild steel—is produced." In the preface the author states that a student's knowledge of engineering materials is often of the vaguest description. Such statements as those quoted will not only leave the student's ideas vague, but he will be actually misinformed.

T.S.

MOLLUSCA.

Monograph of the Land and Freshwater Mollusca of the British Isles.—By John W. Taylor. Part 20. 410-480 pages. Plates XXVI-XXXIII. 471-552 figures. 10-in. × 6-in.

(Leeds: Taylor Bros. Price 7/6.)

Part 20 of Mr. Taylor's "Monograph" practically completes a volume. It contains a description of one of the more interesting of our larger land snails, *Helicigona arbustorum*, which is carried out in the same detail as in the case of other British species. We have never had any great sympathy with varietal names, though they serve to bring out many remarkable variations which are worthy of note. It is interesting that Mr. Taylor has found it necessary to divide the variations in the banding of the shell into two sections, the first of which includes atavistic forms in which the dark peripheral band is placed upon and within a broader, paler, and more or less calcified zone, while the second section includes varieties in which there are recognised differences in the pigmentation and the number of the bands.

The present part also contains an appendix, giving information which has been obtained since the publication of the earlier parts of the "Monograph" and a description of *Vitrina hibernica* detected by Mr. Taylor among material collected by Mr. T. H. Grearson, of Dublin, and described in 1907. The next part will contain the conclusion of the appendix, title page, and the index of the volume. Before concluding we should like to express our unstinted admiration of the coloured plates of *Helix nemoralis* and *Helicigona arbustorum*, which are among those issued with the part.

W. M. W.

PHOTOGRAPHY.

Practical Cinematography and its Applications.—By F. A. Talbot. 262 pages. 93 illustrations. $7\frac{1}{2}$-in. × 5-in.

(William Heinemann. Price 3/6 net.)

Apart from its present vogue as a method of amusement and its commercial aspect, cinematography is of very great importance in scientific work, while its use in education, though already recognised, needs still to be emphasised. A book dealing with the practical aspects of the matter is therefore very much to the point at the present moment. We may pass over the financial side and point out that Mr. Talbot gives some valuable chapters on the use of the camera, and on developing the film, as well as on printing positives. His hints, though brief, with regard to cinematography with the microscope may be mentioned. We feel, however, that an improvement might be made in the title "Micro-Cinematography" which he gives to the chapter. We think that as a picture taken with a microscope is called a photo-micrograph some such word as "cine-micrograph" would be much better than micro-cinematograph. Radio-cinematography is also touched upon, and even the ultra-microscope. Mr. Talbot says, with regard to the educational films, that the attitude of responsible authorities is unfortunately lukewarm, and he gives a good reason, namely, that the producer looks upon the question only from a showman's point of view, but this ought to be easily remedied. Lastly, Mr. Talbot advocates the establishment of national cinematograph laboratories, and no doubt as time goes on we shall see these come into being.

W. M. W.

Handbook of Photo-Micrography.—By H. Lloyd Hind, B.Sc., and W. Brough Randles, B.Sc. 292 pages. 44 plates. 71 figures. 9-in. × 5-in.

(George Routledge & Sons. Price 7/6 net.)

This book gives a very clear description of the various pieces of apparatus used in photographing through the microscope, and also deals with low-power photo-micrography where photographic lenses of small focal length are used without a microscope. We recommend the work as one of reference to those who want to take up the subject with which it deals. The excellent illustrations, some of which are in colour, serve to show the work that can be done by the methods described.

W. M. W.

PSYCHOLOGY.

Minds in Distress.—By A. E. Bridger, B.Sc., M.D., F.R.S. 177 pages. $7\frac{3}{4}$-in. × 5-in.

(Methuen & Co. Price 2/6 net.)

This book is an exceedingly interesting one, particularly on account of the way in which it deals with what the author terms the masculine mind and the feminine mind, which may be possessed to considerable extent by either sex. Of the two main classes of educated people Dr. Bridger says one is very practical, demanding proof before a conclusion is accepted and relying only on facts; the other lives in a different plane of thought altogether, asserting that the effect will be so and so, seeing the end to be attained, little concerned with the process by which it is reached, and devoted to ideas. Among the former (with the masculine type of mind) are those steady, plodding people who achieve financial success or at least stability; among the latter (with the feminine type of mind) are the brilliant, artistic, creative, and spiritual. The genius is of the latter class. The bulk of the book is concerned with the aberrations of the normal types of mind, and is well worth the attention of the scientific and general reader.

W. M. W.

NOTICES.

SUPPLEMENT TO THE "INDEX KEWENSIS."—The Clarendon Press announces that the fourth supplement to the "Index Kewensis," dealing with the years 1906-10, is now ready.

MOTORS STARTED WITH A PUSH-BUTTON.—The Igranic Electric Company has sent us an illustrated pamphlet showing how motors can be controlled by electric push-buttons, which start, accelerate, retard, or stop them. The amount of space that may be saved in the neighbourhood of machines is considerable, for the control gear can be put in a more convenient place.

SPECTROPHOTOMETERS.—Messrs. Adam Hilger, Limited, have published a Bibliography concerning the chemical significance of absorption spectra, which we have pleasure in commending to our readers. Organic compounds and rare earths are dealt with, and the apparatus required for spectrophotometry in the ultra-violet, visible, and infra-red regions is described and illustrated at the end of the booklet.

MINERALS AND THE MICROSCOPE.—Messrs. Murby and Company announce the publication of an introduction to the study of petrology, which has been written by Mr. J. T. Smith, Demonstrator in Geology in the Imperial College of Science, under the title of "Minerals and the Microscope." The aim is to help the student in early difficulties rather than to give him long lists of facts.

NEW BOOKS ON PHYSICS AND CHEMISTRY.—Messrs. J. & A. Churchill will shortly publish the two following new works: "Molecular Physics," by J. A. Crowther, Demonstrator in Physics, Cavendish Laboratory, Cambridge; and "The Synthetic Use of the Metals in Organic Chemistry," by A. J. Hale, Demonstrator, City and Guilds of London Institute, Technical College, Finsbury.

THE LONDON ASTRONOMICAL SOCIETY.—The London Astronomical Society in its circular points out the urgent need for a London astronomical museum. The Society was established to correlate astronomic facts, and on this basis consistent cosmology groups have been established with the following objects: (1) To collect from all parts further facts confirming deductions; (2) to promote fellowship amongst those interested in astronomy and allied sciences; (3) to make practical use of the lessons learnt.

FLOATING BODIES.—The study of equilibrium and floating bodies is a very interesting one, and Messrs. Constable & Company announce that they are about to publish a book on the subject by Mr. B. C. Laws. That it will be of an essentially practical character is shown by the fact that it contains chapters on the stability of ships, floating docks, submarines, and aërial machines. Caissons also come in for attention. The book is intended to be helpful, not only to the student, but to the naval architect in engineering practice.

FOLK-LORE.—In the March number of *The Irish Naturalist* there is a paper by Mr. Nathaniel Colgan on "Field Notes on the Folk-lore of Irish Plants and Animals." One interesting point brought out is the doctrine of sexes in plants, which is upheld all over Ireland. We will give one instance, namely, of the He- and the She-Bulkishawn. Mr. Colgan's informant was a car-driver. The He-Bulkishawn was the rag weed. The She-Bulkishawn—an ingredient in a famous horse medicine—which the driver said was very difficult to find, turned out to be the common tansy.

ZOÖLOGICAL GARDENS OF THE WORLD.—Captain S. S. Flower, the Director of the Zoölogical Gardens of Giza, has kindly sent us the reference list of zoölogical gardens of the world which he annually compiles. There are at present one hundred and seventy-five, the total being made up as follows: Africa, 13; North America, 57; South America, 10; Asia, 27; Australasia, 8; Europe, 60. In many cases the date of the foundation is given and the name of the Superintendent.

CUMBERLAND NATURE RESERVE ASSOCIATION.—The Cumberland Nature Reserve Association, of which the Speaker is President and Major Spencer Ferguson (Mayor of Carlisle) is the Chairman, has now started active work, and is raising a fund to provide keepers or watchers for reserves which it is establishing in the county. Contributions will, if desired, be earmarked for the special protection of the Peregrine Falcon, the Buzzard, and the Raven. The Secretary is Mr. Linnaeus E. Hope, of the Municipal Museum, Carlisle.

THE BIRD-LOVER.—The Brent Valley Bird Sanctuary Committee has issued the first number of an occasional paper, entitled *The Bird-Lover*, which contains articles on "Nesting Boxes," with hints as to how they should be chosen and put up, on "Bird Watching," and other matters of interest to those who are fond of birds. Illustrations and prices of all the types of nesting boxes designed and supplied by the Committee are also given. *The Bird-Lover* (price 6d.) can be obtained from the Secretary of the Committee, Odstock, Hanwell, London, W.

THE JOURNAL OF THE BOARD OF AGRICULTURE.—In the March number of this publication Mr. C. S. Salmon gives a detailed article on spraying experiments on the American gooseberry mildew. Mr. George Massee describes a new disease of narcissus bulbs which is becoming troublesome; and another interesting communication deals with the poisoning of cows through their eating *Rhododendrum ponticum* and its hybrids. Sir Joseph Hooker, in his "Himalayan Journals," records that many of his goats and kids died through eating the leaves of *Rhododendrum cinnabarinum*, which in his day was supposed to be the only poisonous species.

THE WEATHER AT TOTLAND BAY.—The fourteenth annual report on the Meteorological Observations made during the past year at Aston, Totland Bay, Isle of Wight, has been sent to us by the compiler, Mr. John Dover. One of the points about the station is the marked absence of thunderstorms; and, although the rainfall of over thirty-one inches places 1913 among the wet years of Totland, from May 30th to August 30th the total rainfall in ninety-three days was only 1·93 inches. Turning to the temperature, gooseberries were in full bloom on February 19th, and blackberries on December 28th. The brightest day was June 30th, with fifteen hours of bright sunshine.

AMENDMENT OF THE PATENT AND DESIGNS ACT.—Mr. Walter F. Reid, the Chairman of the Institute of Inventors, writes from 20 High Holborn, London, the following letter, which we are pleased to print:—

"As your readers are aware, the amendment of the Patent and Designs Act is now under the consideration of Parliament.

We have already received a number of valuable suggestions from our Fellows on the subject; but as the Institute represents inventors generally we shall be obliged if you will afford us the opportunity of appealing to all those interested who have not yet communicated their views to us."

THE SCOTTISH NATIONAL ANTARCTIC EXPEDITION.—A very strongly supported memorial has just been sent to the Prime Minister, asking for a grant of £3800 from the Treasury towards the completion of the publication of "The Scientific Results of the Voyage of the 'Scotia' to the Antarctic Regions, 1902, 1903, and 1904," by the Scottish National Antarctic Expedition Committee.

Taking into consideration the amount of money given by the Government towards the cost of the Shackleton and Scott expeditions, it is to be hoped that the application will be successful; for there is no doubt that most valuable scientific results have been obtained, and it is only right that they should be published.

SOCIOLOGY.—We have received from the Sociological Society a prospectus of "Interpretations and Forecasts: A Study of Survivals and Tendencies in Contemporary Sociology," by Victor Branford, M.A. (Duckworth). Its review of social and economic movements, and its attempt to give a sociological interpretation of them detached from partisan points of view and political interests, are in continuation of the author's work for the advancement of sociological science as one of the founders of the Sociological Society and its first Honorary Secretary. The author has made arrangements with his publisher by which the profits of the English edition will be for the benefit of the Cities Committee of the Sociological Society, and consequently the Society is interested in making the book widely known for this purpose as well as for the general advancement of the science.

PSEUDO-SCORPIONS. — At the meeting of the Zoölogical Society, held on March 3rd, Mr. H. Wallis Kew read a paper on the building and spinning by Pseudo-Scorpions of the nests in which these animals enclose themselves for moulting, for brood-purposes, and in some cases for hibernation. They are closed cells of spun tissue with or without a covering of earthy or vegetable matters. The tissue is of innumerable threads crossed and coalesced irregularly, without interspaces, and almost like silk-paper. With regard to the spinning apparatus, confusion has existed; but Mr. Kew's observations on living animals place it beyond doubt that the cephalothoracic glands, whose ducts traverse the chelicerae to near the apex of the movable finger and open in the galea, or in the tubercle which replaces it in some groups, are the organs concerned. Contrary to previous statements, the "combs" of the chelicerae have nothing to do with the silk.

MUTTON BIRDS.—At a meeting of the Field Naturalists' Club of Victoria, held in 1912 (see *The Victorian Naturalist*, March, 1912, page 206), Mr. Joseph Gabriel spoke of the exaggerated accounts of so-called cruelty to the Mutton Birds of Phillip Island, and pointed out that the presence of barbed-wire fencing was the primary cause of the numerous deaths and woundings of the birds. Two members questioned the statement, and said that the dead birds, having been found lying in heaps, were evidence of cruelty, and that large quantities of bones scattered about pointed to former slaughter. In the January number of *The Victorian Naturalist* Mr. Gabriel clears the matter up. The heaps of birds, he says, were all young ones, killed outright in order to obtain "beak oil," which is used medicinally. In the second place, a drift of sand took place some years ago at the rookeries, which covered up a number of the holes and smothered the nesting-birds. Recently the sand has drifted in the opposite direction, laying bare the old rookeries and the bones of the dead birds.

WIRELESS TELEGRAPHY.—Mr. G. Marconi delivered a lecture in Rome on March 3rd before the King and Queen of Italy and both Houses of Parliament. He described the progress which had been made in wireless telegraphy, and the difficulties which had been overcome since his previous lecture in Rome in 1903. His voyage to South America on board the "Principessa Mefalda" had illustrated that communication in a north and south direction was easier than communication in an east and west direction. Mr. Marconi described his new system for generating continuous waves, and its use in wireless telephony. He then described the apparatus for producing waves, divided into regular groups, and dealt with the improvements effected in receivers, giving a practical demonstration of the reception of messages in the lecture hall, from Poldhu, in Cornwall and Tripoli. Mr. Marconi finally described the practical applications of radiotelegraphy to all types of vessels, including submarines, as well as its uses in war and peace. He concluded with an acknowledgment of the help which he had received from the King and Queen of Italy.

CRIMINAL ANTHROPOLOGY. — Mr. Arthur MacDonald, of Washington, is advocating in America the establishment of laboratories—using the word in the widest sense—for the study of the criminal, pauper, and defective classes. He thinks that there is no necessity for so much crime as at present exists, and that there should be a thorough scientific investigation of the whole subject of criminal man. Mr. MacDonald has written to the Home Secretary in England pointing out that his plan does not involve great expense; that a bureau for moral, is even more necessary than one for physical, health; and that, although public interest in his work has increased greatly, very little has been done on the scientific side of the subject. He suggests for a practical beginning that a few young men with psychological, medical, and anthropological training should first study the inmates (especially the young) of our penal and reformatory institutions. One of the main objects should be to investigate the causes of crime; then, from the knowledge gained, a rational basis could be furnished for methods of reform. We should very much like to see some action taken in this country in the direction indicated. Mr. MacDonald, who was the President of the Third International Congress of Criminal Anthropology (of Europe), writes from "The Congressional," Washington. He has prepared an interesting pamphlet, entitled "The Study of Man," which sets forth his views, and a list of the public documents which he has written bearing on the subject (to be obtained from the Superintendent of the Senate Document Room) is given on the cover.

THE ROYAL INSTITUTION.—The following are the lecture arrangements at the Royal Institution after Easter: Dr. Walter Wahl, two lectures on "Problems of Physical Chemistry": (1) "Study of Matter at High Pressures"; (2) "Structure of Matter at Low Temperatures" (experimentally illustrated). Professor W. Bateson, Fullerian Professor of Physiology, Royal Institution, two lectures on (1) "Double Flowers"; (2) "The Present State of Evolutionary Theory." Professor D'Arcy W. Thompson, two lectures on "Natural History in the Classics": (1) "The Natural History of the Poets: Homer, Virgil, and Aristophanes"; (2) "The Natural History of Aristotle and of Pliny." Professor A. Fowler, two lectures on "Celestial Spectroscopy: Experimental Investigations in Connection with the Spectra of the Sun, Stars, and Comets." Three Literary Lectures. Professor Svante Arrhenius, three lectures on "Identity of Laws in General and Biological Chemistry." Professor Silvanus P. Thompson, two lectures on "Faraday and the Foundations of Electrical Engineering." Dr. T. E. Stanton, two lectures on "Similarity of Motion in Fluids": (1) "The Theory of Similarity of Motion in Fluids and the Experimental Proof of its Existence"; (2) "The General Law of Surface Friction in Fluid Motion." Professor C. J. Patten, two lectures on "Bird Migration." Professor J. W. Gregory, two lectures on (1) "Fiords and their Origin"; (2) "Fiords and Earth-movements." Mr. Sigismund Goetze, two lectures on "Studies on Expression in Art": (1) "Origin and Development"; (2) "Right Expression in Modern Conditions." The Friday evening meetings will be resumed on April 24th, when the Astronomer Royal, Mr. F. W. Dyson, will deliver a discourse on "The Stars Around the North Pole."

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

MAY, 1914.

ON HAIRS AND HAIR-PIGMENTS.

By H. ONSLOW.

THE origin of the pigments in the hair of men and animals is a subject that has already received much attention, and there exists a wide but scattered literature concerning it.

In spite of the considerable amount of labour that has been expended, the few conclusions arrived at do not seem to rest on a very firm experimental basis. But the attention that has been devoted to Mendelian analysis has given a fresh motive for the elucidation of this problem, and it has acted as a stimulus to further research.

The coat colours of animals form very distinct characters, and for some years it has been largely the custom to use these characters in Mendelian analysis, since by their means the material to be analysed can easily be placed in suitable categories. It is on account of this that further knowledge has been sought with regard to the nature and origin of the pigments underlying such coat colours; for the advantage that the science of genetics would gain, if it were able to express hypothetical pairs of allelomorphic characters in terms of another science, such as chemistry, is too obvious to need further comment. As a matter of fact, this has already, to some extent, been accomplished with regard to the pigments of flowers, though not yet to animal pigments.

Although the colours of animals are very distinct to the superficial glance, yet, under chemical and microscopical investigation, the pigments themselves do not seem to differ so widely; the colours tend to shade into one another, and the nature of the chromogens and the enzymes, which give rise to the pigments, is practically unknown.

STRUCTURE OF THE HAIR.

The structure of the hair is of special importance, for it controls to a considerable degree the macroscopical appearance of the hair, though this has not hitherto been clearly shown to be the case.

A typical hair-shaft is composed of three parts, the medulla, the cortex, and the cuticle. The medulla does not occur in all hairs, but when present consists of a single or multiple column of oval-shaped cells (see Figure 140, C and D), generally surrounded by, but sometimes filled with, air. These cells, containing pigment granules, may be seen in Figures 140 and 141. Next to the medulla —or, in its absence, occupying the entire shaft—is the cortex, composed of a fibrous substance which is resolvable into very long, pointed cells: these may again be reduced to minute fibrils by the continued action of a hot solution of ammonia under pressure. These fibrils do not, as has been supposed, serve to bind the horn-cells together, but they actually compose the body substance of the cells themselves, and the pigment granules frequently lie within them in single rows. Figure 140, A, shows

these rows of granules in the periphery of the hair.

Without the cortex is the cuticle, a layer of flat imbricated cells all pointing upwards, which cover the entire cortex like the scales of a fish. The interstices between the cells of the medulla, and sometimes of the cortex, are at first filled with a liquid, which often dries up, so that air can penetrate, and form a regular pattern or network of canals between the cells. This air may be seen between some of the cells of the big hair in Figure 142. Sometimes the cells themselves are filled with air, so that they swell out and look like small air-bubbles; but it is most usual to find the air present intercellularly.

The air-content or vacuoles show, in many hairs, so regular and homogeneous a pattern, that it is hard to believe that they are due simply to a haphazard shrinkage of the cells, and have no structural signification.

Colour of the Hair.

The colour of human hair depends upon the colour and form of the pigment (*i.e.*, whether it is diffused, or deposited in granules) and upon the vacuoles. These vacuoles appear black by transmitted light on account of their optical properties, but by reflected light they become brilliant white points (see Figures 144 and 145). In light and sandy hair the pigment is chiefly diffused, and of a reddish-yellow colour, but in darker hair the pigment is present as dark brown or black granules. In the hair of albinos, however, of both fair and dark races, as well as in that of certain red-haired people, there occur practically no granules whatever, but only diffused pigment. When stained, human hair that has gone white with age shows no internal structure, but only a few irregular vacuoles, and, unlike white rabbit hair, becomes a pale colour throughout, with no pigment bodies whatever.

Hair of Animals.

Among animals also the pigments and air-content are the chief factors that determine the colour. But there are so many different types of hair among the vertebrates that this description must necessarily be confined to those domesticated animals which have been mostly used in Mendelian analysis, namely, rats, mice, rabbits, and guinea-pigs. The hairs of these animals resemble each other very closely, since they all have a large intercellular air-content; and the three pigments, black, chocolate, and yellow, are apparently the same in the four species. The guinea-pig presents the greatest difference, since the red or yellow type possesses a certain amount of reddish-yellow pigment diffused throughout the medulla and the cortex, and further its hair shows a very perfect reticular system of air-canals, unlike the more vacuolated appearance of mouse and rabbit hairs.

The colours which have been most studied among these animals are black, chocolate, and yellow, caused respectively by black, chocolate, and yellow pigment, and also the dilute types of these colours, namely, blue, fawn, and cream, which are structural modifications of the intense colours. These dilute colours, as they are called, have been considered to be due only to a greater diffusion and a smaller number of the pigment granules than occur in the intense colours. As a matter of fact, this is not a full statement of the facts. A number of careful observations have shown that the intense colours contain only about seven per cent. more granule groups in a given length than the dilute colours, and the size of the granule groups is only seven per cent. larger in the former than in the latter (see Figures 140 and 141), while the size of the granules remains the same. It is true, however, that the pigment granules are not deposited so thickly in the light hairs, and that many of the darker hairs contain granules in the periphery as well as in the medulla (see Figure 140, A). In addition to this, the air-content of the hair plays a very considerable part. Looked at by reflected light (see Figures 144 and 145), the vacuoles appear larger and more conspicuous in the dilute colours, since they are less obscured by the granules. In the intense colours the granules not only tend to hide the vacuoles, but these are also often so distributed throughout the cortex, and between the granules groups, that they absorb the light before it is reflected by the vacuoles, so that the hair appears black or chocolate, instead of blue or silver-fawn, as it would do if more light were reflected.

Within the cells of the medulla and between each vacuole lie the granule groups, which are, on the average, 72μ broad and 112μ long, composed of oval-shaped granules $1{\cdot}2\mu$ broad and $1{\cdot}7\mu$ long. The granules are probably composed, not only of pigment, but also of a ground substance, which may be separated from the pigment by means of alkalies. Inorganic matter is present in this ground substance, possibly as a mordant to the pigment with which it is stained, or possibly as an additional (inorganic) oxydase, which takes part in the oxidation of the chromogen, in the manner of some manganese salts.

In addition to this ground substance, there are, as will be seen later, two other bodies, which go to form the pigment, namely, a colourless chromogen and an oxidising enzyme. The hair of an animal may therefore be colourless for one of three reasons: (1) The absence of either the chromogen or the enzyme; (2) the absence of both chromogen and enzyme; or (3) the presence of an inhibitor of the enzyme. That dominant white flowers, that is to say, white flowers which, in the first generation, give white instead .of coloured offspring when mated to colour, are due to an inhibitor has already been shown. That a chromogen is present in the white hairs of the white Angora cat, the English, Dutch, and albino rabbit, as well as in the white belly of the wild rabbit, may be seen

FIGURE 140.
Black Mouse.

A shows the hair with the central portion in focus.

B The same hair with the periphery in focus.
The pigment granules which absorb the light before it is reflected by the vacuoles may be seen lying in rows within the fibre.

C and D are normal black hairs from which the air has been expelled by caustic soda.

FIGURE 141.
Blue Mouse.

A comparison of C and D with Figure 141 shows that there is little difference between the pigment content of black and blue hairs. The medullary cells filled with pigment granules may be seen surrounded by canals from which the air has been expelled.

FIGURE 142.
White Hair from Black English Rabbit. × 500.
Stained with methyl-violet. The air has been partly expelled from the largest hair, showing clearly the stained granular substance or chromogen.

FIGURE 143.
E shows a diagrammatic sketch of an Agouti hair.
F shows the same of a Steel.
The only portions of the hairs visible when they are lying on the animal are the black and yellow tips.

FIGURE 144. Silver-fawn Mouse.

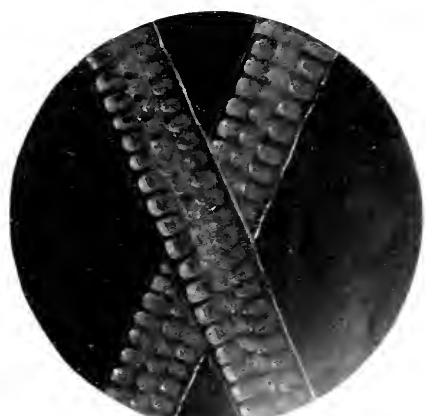
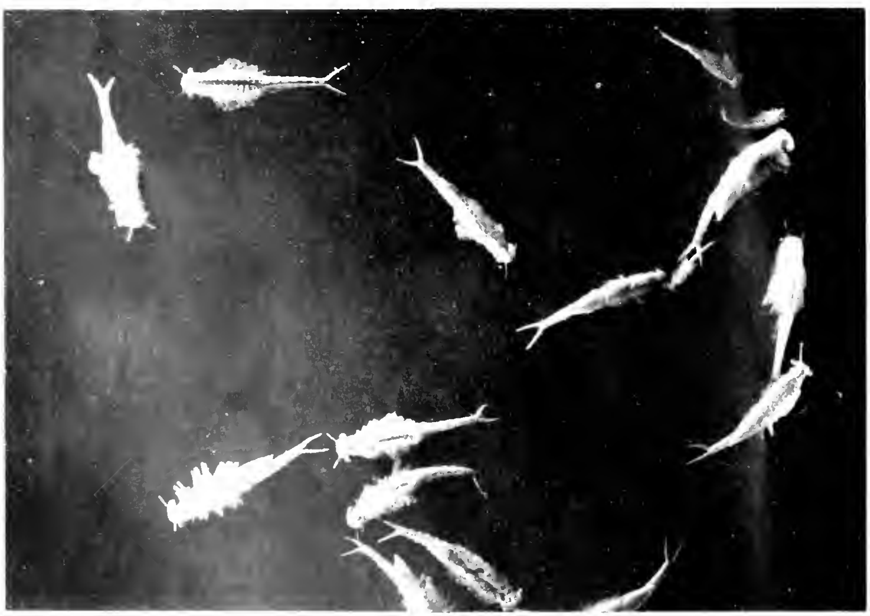


FIGURE 145. Chocolate Mouse.

Seen by reflected light. The vacuoles appear white, and may be seen more obscured in the substance of the hair in the chocolate mouse than in the silver-fawn.

All Figures with the exception of 143 are × 500.

A. M. Kelly, del., 1914.



from the fact that there are present in these white hairs uncoloured granular bodies, in the exact position occupied by the granule groups in coloured hair.* Where the air has been expelled, in Figure 142, they may be clearly seen, after staining in methyl violet, as groups of pigment granules.

Whiteness in these cases is therefore probably due to the presence of an inhibitor, and, in the case of the albino rabbit, to the absence of an oxydase. The white hair of the belly of *Mus sylvaticus*, as well as of albino and piebald mice, possesses, however, no granular body which is capable of taking an artificial stain, and whiteness in these cases is probably due to the absence of chromogen.

Black animals contain black and some chocolate pigment; chocolate and fawn animals contain chocolate and no black; yellow and cream animals contain yellow pigment, with the addition of some chocolate and black pigment, if the animal is heterozygous for black. The agouti, or common wild form of the rat, rabbit, or mouse, is a mixture of all three pigments; most of the hairs have a blue base, then a black and chocolate bar, next a yellow bar, and finally, as a rule, a chocolate tip. Occasionally, in certain mice called reversed sables, the yellow and black bars are interchanged. There is also in rabbits a modification of the agouti, called steel, which lacks the white belly and scut. The hairs have a much narrower bar of yellow, and more developed bars of black, which gives the animal a much darker appearance. A diagrammatic representation of a steel and of an agouti hair is shown in Figure 143. White hairs, such as are found in albinos and piebalds, owe their brilliancy entirely to the large air-content and to the entire absence of pigment.

The Action of Chemicals.

The keratin of the hair is extremely resistant to the action of all reägents, and is only dissolved by the action of caustic alkalies and strong mineral acids. Under the action of caustic soda the yellow pigment is first dissolved, forming a clear yellow solution; next the chocolate, forming a warm brown solution; and, finally, the black pigment granules settle to the bottom, undissolved. None of these solutions give absorption bands.

A very simple technique for examining hairs is to place them under a cover-slip, under which a drop of ten per cent. caustic soda has been run. The alkali immediately drives out the air from the vacuoles, loosens the epithelial cells, and permits the colour of the granules to be observed, without the obscuring effect of the vacuoles.

* If white hair of the English or albino rabbit is treated as if for the extraction of the black pigment, there results in both cases a small quantity of a greyish substance which turns black when dried on the water-bath, and is in appearance somewhat similar to the black pigment. The greyish substance also contains an appreciable amount of cholesterin.

THE FAIRY SHRIMP.

By WILFRED MARK WEBB, F.L.S.

Our readers may recollect that some years ago (see "Knowledge," Volume XXXIII, 1910, page 169) the appearance of the Fairy Shrimp, *Chirocephalus diaphanus*, at Eton was recorded, and a description given of the animal. Later on (see "Knowledge," Volume XXXIV, 1911, page 466) we reproduced some illustrated notes made in the year 1762, which dealt with the occurrence of the crustacean at Norwich. Considerable interest was also aroused at one of the meetings of the Royal Microscopical Society (see *J. R. Mic. Soc.* June 1913, page 250) by the exhibition of a large series of preparations illustrating the development of *Chirocephalus* made by Mr. H. J. Waddington, who, we believe, obtained his material from Cornwall.

It seems that every year since 1910 a few specimens of the Fairy Shrimp have been seen at Eton. During 1913, however, the form was very abundant, and in the winter the specimens grew to a size considerably larger than had previously been noticed. The object of this note is to record these facts as well as to chronicle that the writer succeeded last summer in hatching out and rearing a number specimens from mud collected in 1910, when the small pool in which the crustaceans were first observed had dried up. From this it is evident that the eggs may remain dormant for three years at least.

The accompanying illustrations are from photographs (see Figures 146 and 147) taken by Mr. H. H. Poole and the writer after a considerable amount of experimenting. Fairy Shrimps normally swim about continually, back downwards, with their leaf-like appendages always in motion. It is therefore a difficult matter to photograph them when they are alive and healthy. Figures 146 and 147 were, however, obtained by putting a glass dish containing a number of active Fairy Shrimps on to a piece of black velvet and taking the pictures by flashlight with one of Messrs. W. Watson & Sons' Holostigmat lenses working at $f/4 \cdot 6$.

THE FACE OF THE SKY FOR JUNE.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 23.

Date. Greenwich Noon.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.
	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°	h. m.	°	h. m.	°
June 2	4 38·1	N.22·1	11 32·5	N. 1·8	5 54·2	N.25·6	6 38·7	N.24·7	9 17·9	N.17·3	21 39·1	S.14·8	20 56·6	S. 18.0
„ 7	4 58·6	22·7	16 12·0	S. 26·2	6 31·2	25·3	7 5·1	24·3	9 28·9	16·3	21 39·6	14·8	20 56·3	18·0
„ 12	5 19·3	23·1	21 14·0	S. 13·2	7 2·6	24·4	7 31·2	23·6	9 39·8	15·4	21 39·7	14·8	20 56·0	18·0
„ 17	5 40·1	23·4	0 54·9	N. 9·2	7 28·1	23·0	7 56·8	22·6	9 50·8	14·4	21 39·5	14·9	20 55·5	18·1
„ 22	6 0·9	23·5	5 0·0	N.27·7	7 47·0	21·4	8 22·0	21·3	10 1·8	13·3	21 39·0	14·9	20 55·0	18·1
„ 27	6 21·7	N.23·4	9 40·4	N.15·4	7 58·9	N.19·7	8 46·6	N.19·9	10 12·9	N.12.3	21 38·2	S.15·0	20 54·4	S. 18·1

TABLE 24.

Date. Greenwich Noon.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
	°	°	°	°	°	°	°	h. m.	°	°	°	°	h. m.	h. m.
June 2	−15·2	−0·4	23·6	+21·8	+1·2	+18·2	208·0	10 25 *e*	−21·1	+0·2	62·3	224·9	8 7 *e*	5 47 *m*
„ 7	13·3	+0·2	317·5	+10·2	2·9	19·0	159·6	1 4 *m*	21·1	0·2	132·0	256 5	8 23 *m*	2 50 *e*
„ 12	11·2	0·8	251·3	−16·0	4·6	19·8	111·1	4 23 *m*	21·1	0·3	201·9	288·2	4 19 *e*	4 2 *m*
„ 17	9·1	1·4	185·1	−21·6	6·3	20·5	62·6	7 43 *m*	21·1	0·3	271·8	320·0	2 24 *e*	11 1 *e*
„ 22	6·9	2·0	118·9	− 6·1	8·0	21·2	14·0	11 2 *m*	21·0	0·3	341·7	351·8	2 39 *m*	0 13 *e*
„ 27	− 4·0	+2·5	52·7	+17·6	+9·7	+21·9	325·4	2 22 *e*	−21·0	+0·3	51·8	23·7	8 25 *e*	1 25 *m*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m·4$, $9^h\ 55^m·6$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN reaches the Solstice at 7 a.m., on 22nd, when Summer begins and the day is longest. Its semi-diameter diminishes from 15′ 48″ to 15′ 45″. Sunrise changes from $3^h\ 52^m$ to $3^h\ 48^m$; sunset from $8^h\ 4^m$ to $8^h\ 18^m$. There is no real night in June.

MERCURY is an evening star. Semi-diameter 3″ to 5″. Illumination diminishes from $\frac{4}{5}$ to $\frac{1}{3}$. In elongation 24° 55′ E on 19th, 10′ South of Neptune on evening of 25th.

VENUS is an evening star, $\frac{5}{8}$ of disc illuminated. Semi-diameter 6″. Occulted by Moon on 26th (see below). 2° 14′ North of Neptune on morning of 17th.

THE MOON.—First Quarter $1^d\ 2^h\ 3^m$ *e*; Full $8^d\ 5^h\ 18^m$ *m*. Last Quarter $15^d\ 2^h\ 20^m$ *e*. New $23^d\ 3^h\ 33^m$ *e*. First Quarter $30^d\ 7^h\ 24^m$ *e*. Perigee $5^d\ 11^h$ *e*. Apogee $17^d\ 9^h$ *e*, semi-diameter 16′ 29″, 14′ 47″ respectively. Maximum Librations, 7^d 7° N, 11^d 7° W, 21^d 7° S, 25^d 5° E, July 4^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 27).

MARS is advancing through Cancer and Leo, 45′ N. of Regulus on 23rd. Occulted by Moon May 30th, 5^h *e*. The semi-diameter during June diminishes from 2″·6 to 2″·3. The unilluminated lune is on the East: its width diminishes from $\frac{1}{2}$″ to $\frac{1}{3}$″.

JUPITER is a morning star in Capricornus; it passes Stationary Point on 11th. Polar semi-diameter, 20″·5.

Configuration of satellites at 2^h *m* for an inverting telescope.

TABLE 25.

Day.	West.		East.		Day.	West.		East.	
June 1	2	○	134		June 16	1	☉	24	
„ 2	1 3	○	24		„ 17	3	○	124	
„ 3	3	○	124		„ 18	321	○	4	
„ 4	32	○	4	1 ●	„ 19	32	○	14	
„ 5	1	○	4	3● 2●	„ 20		○	324	1 ●
„ 6		☉	123		„ 21	1	☉	4 3	
„ 7	412	○	3		„ 22	2	○	143	
„ 8	42	○	13		„ 23	14	○	32	
„ 9	413	○	2		„ 24	43	○	12	
„ 10	43	○	12		„ 25	4321	○		
„ 11	4321	○			„ 26	432	○	1	
„ 12	43	☉		2●	„ 27	4	○	32	1 ●
„ 13	4	○	132		„ 28	41	○	23	
„ 14	124	○	3		„ 29	42	○	13	
„ 15	2	○	143		„ 30	41	○	23	

The following satellite phenomena are visible at Greenwich, $3^d\ 3^h\ 31^m\ 10^s$ *m* I. Sh. I.; $5^d\ 0^h\ 15^m\ 4^s$ *m* I. Sh. E.; $1^h\ 15^m\ 3^s$ *m* III. Ec. D.; $1^h\ 29^m\ 16^s$ *m*, I. Tr. E.; $6^d\ 2^h\ 14^m\ 56^s$ *m*, IV. Tr.

E.; $11^d\ 2^h\ 38^m\ 15^s\ m$, I. Ec. D.; $11^d\ 11^h\ 52^m\ 48^s\ e$, I. Sh. I.; $12^d\ 1^h\ 3^m\ 7^s\ m$, I. Tr. I.; $1^h\ 30^m\ 59^s\ m$, II. Ec. D.; $2^h\ 8^m\ 31^s\ m$, I. Sh. E.; $3^h\ 18^m\ 56^s\ m$, I. Tr. E.; $13^d\ 0^h\ 37^m\ 54^s\ m$, I. Oc. R.; $14^d\ 1^h\ 34^m\ 56^s\ m$. II. Tr. E.; $15^d\ 11^h\ 47^m\ 4^s\ e$, III. Tr. I.; $16^d\ 3^h\ 24^m\ 46^s\ m$, III. Tr. E.; $19^d\ 1^h\ 46^m\ 9^s\ m$, I. Sh. I.; $2^h\ 51^m\ 37^s\ m$, I. Tr. I.; $20^d\ 2^h\ 26^m\ 45^s\ m$, I. Oc. R.; $20^d\ 11^h\ 34^m\ 36^s\ e$, I. Tr. E.; $21^d\ 1^h\ 5^m\ 46^s\ m$, II. Tr. I.; $1^h\ 48^m\ 31^s\ m$, II. Sh. E.; $22^d\ 3^h\ 31^m\ 43^s\ m$, IV. Sh. I.; $22^d\ 11^h\ 6^m\ 53^s\ e$, III. Sh. I.; $23^d\ 2^h\ 44^m\ 10^s\ m$, III. Sh. E.; $3^h\ 23^m\ 1^s\ m$, III. Tr. I.; $26^d\ 3^h\ 39^m\ 30^s\ m$, I. Sh. I.; $27^d\ 0^h\ 55^m\ 9^s\ m$, I. Ec. D.; $27^d\ 11^h\ 5^m\ 45^s\ e$, I. Tr. I.; $28^d\ 0^h\ 24^m\ 3^s\ m$, I. Sh. E.; $1^h\ 21^m\ 59^s\ m$, I. Tr. E.; $1^h\ 30^m\ 7^s\ m$, II. Sh. I.; $3^h\ 29^m\ 23^s m$, II. Tr. I.; $30^d\ 0^h\ 40^m\ 0^s\ m$ II. Oc. R.; $3^h\ 5^m\ 38^s\ m$ III. Sh. I.

The eclipses will take place to the left of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN and NEPTUNE are too near the Sun for convenient observation.

URANUS is a morning star, but badly placed; near Moon on morning of 12th.

COMETS.—See "Notes on Astronomy."

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant.		Remarks.
	R.A.	Dec.	
	°	°	
May-30-Aug.	333	− 28	Swift, streaks.
May-June	280	− 32	Swift.
May-July	252	21	Slow, trains.
June-Aug.	310	61	Swift, streaks.
June-Sept.	335	57	Swift.
June-July	245	+ 64	Swift.
June-Aug.	303	− 24	Swift.

In the cases where the radiant is stated to be active for several months, there is a difference of opinion as to whether it can be regarded as a single shower or a combination of several.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable (see Table 26).

TABLE 26. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
X Herculis	16 1	−47·5	5·8 to 7·2	irregular.	
R Herculis	16 2	−18·6	8·0 to 14·7	317·7	April 14.
SX Herculis	16 4	+25·1	7·9 to 9·2	100·55	June 18.
W Coronae	16 13	+38·0	7·8 to 13·5	238	July 26.
g Herculis	16 26	+42·0	4·7 to 5·5	unknown	
SS Herculis	16 29	+ 7·0	8·0 to 12·5	103·9	May 23.
S Ophiuchi	16 29	−17·0	8·3 to 13·5	233·69	June 15.
S Draconis	16 41	+55·1	7·5 to 10·0	300	June 22.
u Herculis	17 14	−33·2	4·8 to 5·3	2·05102	Algol Star.
Z Ophiuchi	17 15	− 1·6	7·6 to 12·6	349·3	May 26.

Minimum of *u* Herculis June $2^d\ 3^h{\cdot}7\ m$. Others may be found from period.

Principal Minima of β Lyrae June $3^d\ 11^h\ m$, $16^d\ 9^h\ m$, $29^d\ 7^h\ m$. Period $12^d\ 21^h{\cdot}8$.

TABLE 27. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reäppearance.	
			Time.	Angle from N. to E.	Time.	Angle from N. to E.
1914.			h. m.	°	h. m.	°
June 4 ..	83 Virginis	5·6	11 38 *e*	184	0 4 *m**	229
,, 4 ...	85 Virginis ...	6·1	11 42 *e*	56	0 15 *m**	354
,, 5 ...	BAC 4814 ..	6·5	6 47 *e*	90	7 45 *e*	330
,, 7 ...	BAC 5603 ...	6·0	9 20 *e*	165	9 55 *e*	224
,, 10 ...	7 Sagittarii ..	3·5	2 59 *m*	84	4 9 *m*	242
,, 13 ...	δ Capricorni	3·0	0 19 *m*	118	1 2 *m*	190
,, 20 ...	47 Arietis... .	5·8	—	—	1 31 *m*	195
,, 21 ...	27 Tauri	3·7	—	—	1 48 *m*	205
,, 21 ...	28 Tauri	5·2	—	—	1 57 *m*	228
,, 26 ...	Venus	—	7 51 *m*	173	8 12 *m*	213
,, 26 ...	Wash. 626	7·3	8 27 *e*	163	—	—
,, 27 ...	Wash. 672	7·0	9 53 *e*	153	—	—

From New to Full disappearances take place at the Dark Limb, from Full to New reäppearances.

The asterisk indicates the day following that given in the date column.

Attention is called to the occultation of Venus on the morning of the 26th: it will take place in daylight at a somewhat low altitude in the east, the Moon being a thin crescent, 2¾ days old.

SPORE DISPERSAL IN THE LARGER FUNGI.

By SOMERVILLE HASTINGS, M.S., F.R.C.S.

(With illustrations from photographs by the writer.)

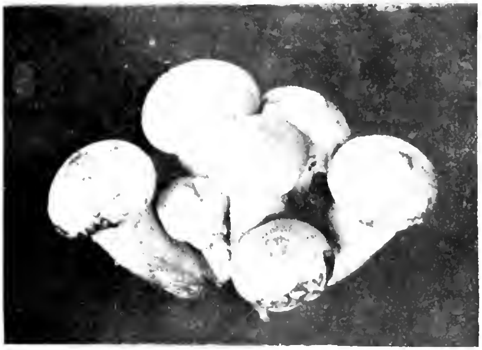
(Continued from page 128.)

VERY different from the species so far described, whose spores are distributed singly by the wind, are the Bird's Nest fungi. Within the cup-shaped "nests" flattened masses of spores become developed, each surrounded by a dense protective covering which is itself attached to the nest by a fibrous cord. When dry this cord is brittle, but when moist it is so elastic that it can be stretched out five or six inches before it breaks. The loose tissue between the eggs soon disintegrates, and later on the elastic cords give way and the spore masses become distributed. Last of all, the coverings of the spore masses decompose and the spores germinate. Two forms are illustrated in Figures 150 and 153. The Common Bird's Nest (*Crucibulum vulgare*) differs from the Striated Bird's Nest (*Cyathus striatus*), not only in the absence of striations on the inside of the nest, but also by possessing no depressed area where the cords are attached to the "eggs." Both species grow on rotting twigs. The specimen of the Common Bird's Nest here shown was kept growing on some old canvas for several months, and it was very interesting to watch its development.

We have next to consider fungi which shoot out their spores in masses to a considerable distance. The Catapult Fungus (*Sphaerobolus stellatus*) (see Figure 152) is one of the best known of these. It is a tiny little thing, not much larger than a pin's head, but fortunately it grows in groups surrounded by more or less whitish mycelium, otherwise it would be very difficult to find. It is not uncommon on decaying wood, and in its early stages of development each tiny fungus looks like a little white or orange-coloured seed. The body of the fungus is formed of two layers, or coats, which are but slightly adherent to each other, except on the top. Enclosed by the inner coat is a sticky mass of spores. When the fungus is ripe both coats split radially above, so that a little star-like cup is formed, surrounded by half a dozen rays, with a dark, shining mass of spores at the bottom of it. Very soon the inner coat, which is only attached to the outer edge at the tips of the rays, suddenly turns inside out, driving before it the mass of spores. The opalescent inner coat now looks like a tiny pearl. The shooting is too rapid to be followed by the eye, but is so efficient that the little brown mass of spores is projected a distance of one or two feet. It is a fascinating process to watch, and should the observer have but little time or patience at his disposal an open cup can be made to shoot out its spores by lightly pressing on its outer coat with the point of a pin.

Several of the smaller fungi which grow on dung also shoot their spores. In *Ascobolus immersus*, an Ascomycete, the eight large spores of each ascus are shot out, sticking together as a single mass, to a distance of about a foot. Two interesting facts have been made out about this tiny fungus. The little plant always turns towards the light and shoots its spores in this direction, and spore discharge is periodic and only occurs by day. Remembering that the fungus grows on dung, it is easy to see that the spores are discharged only in the direction of the light, so that they may pass clear of neighbouring obstructions and fall some distance from the parent plant. They are discharged only by day, because only at this time is the directing action of light present. *Pilobolus crystallinus* also comes up on dung as a tiny crystalline droplet, with a little black spot on top. Like *Ascobolus*, it always turns towards the light before shooting its spores; but it differs from *Ascobolus* in that each spore-mass consists of some hundreds of spores and not eight only. Further, the spore-masses are shot to a longer distance, and *Pilobolus longipes* will project its spores a distance of from three to six feet. Sometimes the sound of the spore discharge can actually be heard. Buller describes how, with *Pilobolus Kleinii*, he was able to make out two sounds: first a little click as the spore mass left the fungus, and then a further sound when the projectile struck the side of the containing dish or other object. An interesting demonstration of the accuracy of the aim of *Pilobolus* can be made by covering the dung on which it grows with a cardboard box having a circle, say, two inches in diameter, cut in its centre, and a small piece of glass as cover to this hole. A very large proportion of the little black spore-masses will be found within the glass-covered circle.

But what advantage, it may be asked, is it to fungi which grow on dung to project their spores to such long distances? In nature the spores shot out by the fungus usually fall on grass or other vegetation, and are then accidentally eaten by cattle and other herbivora, and, passing unaffected through the alimentary canals of these animals, and



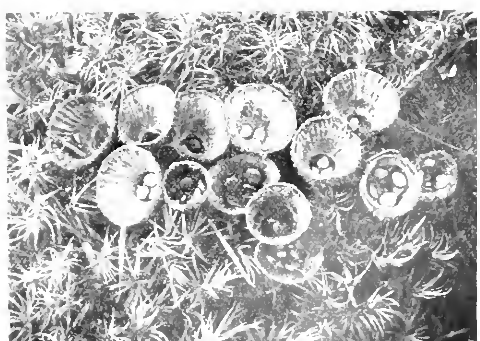
F[illegible] Immature [illegible] *Lycoperdon* [illegible]

[illegible] *Lycoperdon* [illegible]

FI[illegible] The Star [illegible] *Geaster* [illegible]

F[illegible] The Catapult [illegible] *Sp[illegible] stellatus* [illegible] shoot- [illegible] to a distance of one or two feet. [illegible]

FIGURE 180. The Common Bird[illegible] N[illegible] *Crucibulum vulgare*, [illegible]



F[illegible] The St[illegible]

FIGURE 154. *Anellaria separata.* A common fungus which grows almost exclusively on dung.

FIGURE 157. The Stinkhorn (*Ithyphallus impudicus*) with flies devouring the mucus.

FIGURE 155. *Boletus chrysenteron.* showing tooth-marks of a squirrel.

FIGURE 158. *Boletus badius*, showing tooth-marks of a squirrel.

FIGURE 156. The Stinkhorn (*Ithyphallus impudicus*) with immature specimens, one in section.

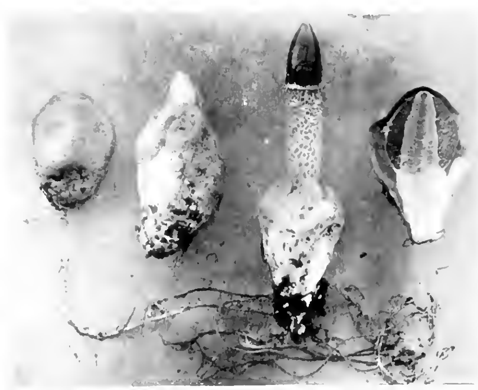


FIGURE 159. The Dog Stinkhorn (*Mutinus caninus*) in various stages of development and in section.

becoming thoroughly mixed with decomposing vegetable matter, are deposited under ideal conditions for germination and growth. Many fungi have been grown from the contents of the intestines of recently killed rabbits, extracted under conditions which made it impossible that any spores should have reached them through the air. Besides these tiny fungi a large number of dark-spored toadstools of the genera *Anellaria*, *Coprinus*, and *Panaeolus* (see Figure 154) are also found almost exclusively on the dung of horses and cattle; indeed, the existence of not a few of these fungi seems to be entirely dependent on that of some one or other of the herbivora. Occasionally, of course, the spores may be carried to the dung directly by the wind, but much more usually they are first deposited on grass or other herbage, and are then swallowed by the animal and pass unharmed through its body.

We see, therefore, that some toadstools make use of both wind and animal agencies to effect their spore dispersal. When we consider the vast number and small size of the spores of many fungi we shall understand how frequently they must become deposited on the grass, leaves, and fruits which form the regular foods of beasts, birds, and insects. It is quite possible that the spores of a large number pass unharmed through the alimentary canals of these creatures, and are thus deposited under conditions peculiarly suitable for their germination and growth.

But not only are the spores of many fungi unconsciously eaten by animals, but certain other fungi which grow underground are themselves eagerly sought for by pigs and other animals and greedily devoured. The fact that the edible truffles are only strong-smelling when quite mature, and filled with ripe spores, suggests that this must be a coöperative process, and that it is really to the interest of the fungus to be thus devoured. Truffles are also eaten by a variety of beetle (*Leiodes cinnamomea*), and it may be that this creature is important in the dispersal of their spores. It is also possible that the smaller mammals, such as rabbits and squirrels, may also assist in the spore distribution of certain fungi. During the past year I found three different species of Boletus showing unmistakable evidence of having been eaten by squirrels (see Figures 155 and 158), and also saw a species of Flammula (a gill-bearing toadstool, with rust-coloured spores), marked by the claws of a small animal, fall from a branch of a tree on which a squirrel was sitting. The fruits of *Fomes annosus* (see Figure 116) are usually developed on the exposed roots of Conifers on which the plant grows. I have on several occasions seen them forming part of the roof or sides of rabbit-burrows, and would suggest that the rabbits which brush against the fungus must assist in its spore-dispersal, chiefly through the air-currents that they produce in passing.

There are three British fungi which show an unmistakable adaptation for the dispersal of their spores by insects. Two of these are fairly common and one is exceedingly rare. Two or three closely related species from Australia have been accidentally introduced into this country, but do not seem to be spreading. The Common Stinkhorn (*Ithyphallus impudicus*) (see Figures 156 and 157) is very common in woods. In its early stages it closely resembles an ordinary hen's egg with a softened shell; indeed, the fungi in this stage are spoken of as "ghost's eggs" by the peasants of Kent. The "egg" is white, and projects slightly above the ground. Its lower extremity is attached to a branched white cord, which can sometimes be traced for one or two feet through the soil, and may lead to a second "egg." The branched cord is the mycelium, or fungus plant, while the "egg" is its fruit. The "egg" grows until mature, when the outer gelatinous coat ruptures at the top, and the stalk, which had previously resembled a compressed sponge, rapidly expands until, in two or three hours, it has increased in length from an inch and a half to five or six inches. Carried aloft by the white stalk is a conical cap which is also white, but its colour is at first obscured by a dark-green, glutinous substance in which are embedded the spores. The dark-green gluten is sweet to the taste, and is at first fairly solid. But almost as soon as the elongation of the stem is complete it begins to liquefy and form droplets, and it is now that the object of the vertical and horizontal projections on the cap become clear. About this time also the whole fungus, and especially the slimy material on top, which had at first only a faint and not unpleasant smell, begins to exhale a most foetid and disgusting odour. Wasps, blue-bottles, and smaller flies are attracted by the smell, and eagerly devour the dark-green gluten with its contained spores; and so greedy are they that comparatively rarely do we find a fully developed Stinkhorn with any trace of the dark slime upon it. The spores pass unchanged through the insect's body, and in this way dissemination is effected. Spores from the excreta of flies that had been fed on this fungus were placed in tubes on sterilised earth and germinated in two months, producing mycelium. The Dog Stinkhorn (*Mutinus caninus*) (see Figure 159) also grows in woods, but is less abundant than the Common Stinkhorn. It is a smaller fungus, and has no definite cap at the end of the stem. Usually it has no smell, but sometimes a faint odour can be detected. The last half-inch of the stem is covered with dark olive-green mucus, which is itself at first overlaid by a greyish film. When the spore-containing mucus is removed by the small flies that feed upon it the bright-red extremity of the stalk becomes visible. The Lattice Fungus (*Clathrus cancellatus*) is extremely rare. When mature a hollow sphere, formed by dark-red anastomosing branches, is seen. On this framework is spread the dark-green, spore-containing mucus. The whole thing is abominably foetid.

The Devil's Snuff-box (*Scleroderma vulgare*) (see Figure 161) is a puffball, with a thick coat, which never spontaneously ruptures, and resists decay for a long time. In its early stages of development the interior is firm and solid, but later a dark-brown, powdery mass of spores is developed in it. Specimens found in nature have often a number of holes about a quarter of an inch in diameter in the lower part of their leathery coverings; these are the work of beetles, which eat their way into the fungus, and are probably of considerable assistance to the plant in the dispersal of its spores.

But toadstools, and particularly the gills of those that possess them, are very frequently eaten by slugs, and the observations of Voglino tend to show that this is not altogether disadvantageous to the fungus plant; for the germinating spores of species of *Russula* and *Lactarius* (see Figure 160) were found in the digestive tracts of slugs fed on these toadstools. Further, the spores of other species that would not germinate on ordinary culture media were found to do so readily in the fluid from the digestive tract of the slug. Slugs are eaten by many birds which often fly long distances, and it is possible that in this way the wide distribution of some species of fungus is to be explained. The germinating spores of species of *Lactarius* and *Russula* have been actually found in the digestive tracts of toads caught in pine woods, and were probably derived from the slugs that they had eaten. Perhaps the most striking of Voglino's observations was the following. Ten specimens of a toadstool (*Hebeloma fastibile*) were enclosed as they grew, and four starved slugs introduced. The toadstools were eaten, especially their gills. One of the slugs was killed, and germinating spores of *Hebeloma fastibile* found in its digestive tract. The other three were left in the enclosure, which was watered with sterilised water, and kept enclosed for nearly a year. Specimens of *Hebeloma* were then found to be more numerous within it than elsewhere in the neighbourhood. Slugs are very careful, however, as to the variety of toadstool that they care to tackle. Experiments with slugs kept without food for a couple of days showed that, while the Stump Tuft (*Armillarea mellea*) (see Figure 77), the Emetic Russule (*Russula emetica*), and the Scarlet Fly-cap (*Amanita muscaria*) (see Figure 162) were readily eaten, the Sulphur Tuft (*Hypholoma fasciculare*) and the Melon Hygrophorus (*Hygrophorus pratensis*) remained practically untouched. The Death-cup (*Amanita phalloides*) (see Figure 165), the most poisonous of British toadstools, is sometimes found eaten by slugs, and it will be seen from the above that other forms which are poisonous to ourselves do not appear to be harmful to less highly organised creatures. It seems probable, therefore, that species of *Lactarius* and *Russula* are greatly assisted by slugs in their spore dispersal, and it is possible that other fungi find these creatures of secondary value also. In all these forms, however, the wind is of first importance.

Lastly we come to fungi whose spores are distributed by insects on which they themselves parasitically grow. The Caterpillar Fungus (*Cordyceps militaris*) (see Figure 163) is a truly marvellous plant. The club-shaped fruit shown in the illustration is bright scarlet-red, and stands up about an inch above the ground. It is covered with tiny pits from which the ascospores are shed. The fungus is parasitic on caterpillars, and its spores enter the unfortunate insect either through the spiracles or are swallowed with its food. The infection takes place slowly, and the insect has usually passed into the chrysalis stage before it is killed by the fungus. Its body is then replaced by a dense web of fungus mycelium; but even in this state the outward form of the chrysalis is still, as a rule, visible, though it was lost in the specimen photographed. Before producing the fruit here illustrated the fungus often throws up a short-branched process, which buds off minute spores (conidia). In autumn the bright-red fructification appears above the surface of the ground in which the remains of the chrysalis lie buried. A larger form, *Cordyceps sinensis*, is sold in bundles, with the caterpillar still attached, as a regular article of diet in China, and can even be purchased in certain shops in London.

Though hardly one of the larger fungi, it is difficult to close without a brief description of *Empusa muscae* (see Figure 164), which causes so destructive a disease to the common house-fly. In late autumn and early winter it is very common to find dead flies sticking to looking-glasses, pictures, and window-panes. If these be closely examined each will be seen to be surrounded by a sort of halo, and if looked at with a pocket lens the halo will resolve itself into a number of small white spores. The fungus grows parasitically in the interior of the fly and slowly kills it. The fine threads of the mycelium then perforate the insect's body, and bud off the relatively large spores. These are shot out to a distance of a quarter to three-quarters of an inch by rupture of the filaments bearing them, and as they adhere to any object struck other flies readily become infected.

In conclusion, the writer feels compelled to acknowledge that very few of the observations recorded in the foregoing pages are really original. They are mainly the result of the work referred to in the following bibliography, especially that of A. H. R. Buller:—

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FIGURE 160. *Lactarius rufus.* A Toadstool with a white milky juice. Specimens of this genus are often found eaten by slugs.

FIGURE 163. The Caterpillar Fungus (*Cordyceps militaris*), which grows parasitically on the larvae of butterflies and moths.

FIGURE 161. The Devil's Snuff-box (*Scleroderma vulgare*). A Puffball with a thick leathery coat which never spontaneously ruptures.

FIGURE 164. *Empusa muscae*, which grows parasitically on the common house-fly.

FIGURE 162. The Scarlet Fly-cap (*Amanita muscaria*). A brilliantly coloured but very poisonous toadstool.

FIGURE 165. The Death-cap (*Amanita phalloides*), the most deadly of all toadstools, which is responsible for nine-tenths of all deaths from fungus-poisoning.

FIGURE 167. Section of tapioca, showing starch grains; stained with iodine. × 200.

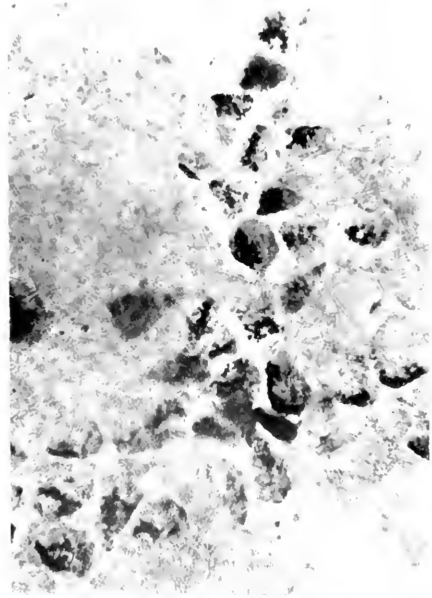


FIGURE 168. "Improved" raspberry jam containing apple cells; stained with iodine. × 75.

FIGURE [illegible]. Potato starch [illegible]

FIGURE 169. "Improved" strawberry jam, showing gooseberry cells. Seen by polarised light. × 75.

MICROSCOPICAL AND COLLOIDAL EXAMINATION OF JAMS.

By ERNEST MARRIAGE, F.R.P.S.

THE analysis of these important foodstuffs to-day is not equal to the power in the hands of adulterators. Careful adulteration of a jam with a cheaper fruit jelly means a certain outlay in plant, but an expenditure of money in this direction enables manufacturers to adulterate, or, as they say, "improve," their jams and to defy analysts. Anyone who takes the trouble to record cases of prosecutions will see that the caught culprits are, as a rule, small firms; the larger and well-known makers, though often equally blameworthy, escape detection.

Chemical analysis is of little or no assistance in detecting the blending of two or more fruits in jam. Fruit acids are very nearly related, and impossible to isolate, whilst they occur in varying proportions in most fruits. Malic acid is not confined to apples, nor citric acid to lemons, and so on. Possibly it might be worth while to examine jams for oxalic acid, as an indication of rhubarb adulteration. The iodine test for starch is useful if an apple adulterant, which has not been thoroughly filtered, is employed, as many apple cells contain starch; but even a home-filtered apple jelly may fail to show the marked blue reäction. Figure 166 shows a section of apple stained with iodine: the numerous dark spots are starch grains. In the boiling to which the fruit is subjected the starch is broken up and diffused throughout the cell, but the cell walls are not broken, and the contents of the cell show the characteristic colour. Figure 168 is a specimen of "improved" raspberry jam in which the iodine test reveals the nature of the adulterant. Note the cells of apple containing starch, which are black in the figure. Gooseberries, another common diluent of the more costly jams, are free from starch, so iodine is no use in that connection.

Another chemical test consists in the introduction of alcohol into a solution of jam whereby the pectin is thrown out. The comparative absence of pectin is characteristic of strawberries, and affords some criterion of the purity of a strawberry jam: it is the alleged pretext for adulterating this preserve with gooseberry or apple jelly. Yet other fruits, rich in pectin, black currants, for example, are treated with an admixture of apple. Looking deeper for the common cause of both these sophistications, we find that apples or gooseberries are cheaper for the jam-maker to use than strawberries or black currants.

Useful quantitative records of adulteration of jams with apple pulp can sometimes be obtained by the iodine test and photography without the aid of a microscope; but as the amount of starch present in apples is variable, depending on the maturity or ripeness of the fruit—probably upon the variety as well—the results obtained are now and then disappointing. In any case the darkened cells are only a proportion of the whole, and must not be taken to represent the total adulteration. A lens of short focal length, say two inches, and a camera with a long extension are necessary. The sample to be tested is made up in the form of a microscope slide, and an enlarged negative, preferably of the whole of the preparation, is taken in the camera. With an enlargement of ten diameters the darkened apple cells can readily be seen and their number counted. To prepare the slide, a drop of jam, free from pips, is placed on a micro-slip and mixed with a trace of iodine solution; a three-quarter-inch circular cover-glass is placed on the jam, and pressed down with a cork five-eighths of an inch in diameter, until the layer imprisoned is as thin as possible. The slide is then ready for the photographer. An isochromatic plate should be used, in conjunction with a yellow screen, to cut out the blue rays. Records obtained in this way of a pure raspberry jam and one "improved" with apple are shown in Figure 170. The left semi-circle is the pure jam, whilst the dark oval specks in the other show the presence and frequency of the adulterants in the second sample. Micro-slides made in the above way are, of course, equally available for photomicrography, and the coloration of the apple cells makes them much easier to record (as we have seen above) than in their almost transparent, unstained condition; but the limited area included in a photomicrograph is insufficient to give even an approximate idea of the extent, though it affords positive proof of the existence of the adulteration.

Failing satisfactory chemical tests, the microscope offers a quick and ready method of picking out fruit adulterants, subject to the proviso that perfect filtration has not been employed. Microscopical examination of all foodstuffs is a highly important branch of analytical work. For investigating jams a high magnification is not required; an enlargement of fifty to one hundred diameters is generally sufficient. In making photomicrographic records it is well to keep to one standard magnification: by so doing there is less danger of confusion. The cells of apple are smaller than those of gooseberry or plum, but at a higher magnification might easily be mistaken for either of the latter less magnified.

When recourse is had to the microscope, three or four methods of examination are available, viz.,

by transmitted light, dark ground illumination, opaque illumination, and polarised light. Of these, without doubt, the polariscope is the best optical means of showing the fruit structure and cells in an unstained slide. I have dealt with the value of the iodine test for apple: the polariscope is especially useful in the detection of gooseberry. Gooseberry cells are large, but the main characteristic of the fruit is that a fair proportion—not all—of the cells show bright minute specks when the nicols of the polariscope are crossed. Figure 169 shows gooseberry cells in an "improved" strawberry jam. I do not know the nature of these specks: they are not crystals, the raphides of the microscopist.

There is no great need to dwell upon the special characteristics of more costly fruit, as in spite of the fact that jam-makers claim on their labels to improve their wares, they invariably do so with cheaper fruit. Minute hairs from the skin of the fruit are very apparent in raspberry (see the minute tubes in Figure 168) and loganberry jams, but are occasional only in blackberry or strawberry, and absent from apples, currants (red and black), gooseberries, and plums.

Familiarity with the appearance of pure jams is, of course, essential, and for this experience it is best to rely entirely on jams made at home. The number of manufacturers who make pure jams is small, and they are being forced out of the trade by fraudulent competition. Sections of the actual fruit, too, should be examined. These are not easy to prepare. Thin sections can be obtained by infiltration with paraffin or celloidin, but I think that the results so obtained are misleading, and that sections of the fresh fruit, say one hundredth of an inch (or more) thick, soaked in dilute formaldehyde and then mounted in glycerin jelly, are more suitable.

Though the use of the polariscope is of prime importance, the ordinary examination by transmitted light must in no wise be neglected. Dark-ground illumination, unless the polariscope is not available, is of minor importance. Opaque illumination by the Lieberkuhn, though useless for jams, is valuable for dealing with pips, or examining the surface of fruits or vegetables in their natural state. I shall have occasion again to refer to the Lieberkuhn below.

The examination of jams for incriminating fruit details is useful up to a certain point, but when the adulterant has been carefully filtered the microscopist may make his bow and gracefully retire from the contest with the adulterator, as the chemist has practically done at the outset. We have seen already, with the iodine test, that a combination of chemistry and microscopy has advantages over the individual sciences. In that case we were dealing with unfiltered jams; may not the same hold good with filtered jellies?

In February, 1911, Mr. Emil Hatschek read a paper, "A Study of some Reactions in Gels," before the Society of Chemical Industry (see the *Journal of the S.C.I.*, March 15th, 1911, No. 5, Vol. XXX), in which he showed that precipitates of certain insoluble salts in various gels differed, not only from precipitates obtained in corresponding aqueous solutions, but also among themselves. He suggested to me that a study of the precipitates formed in fruit jellies might give a clue to their origin, and so enable adulteration to be detected. As the lead iodide reäction gives very different results in gelatine and agar-agar, it seemed to offer the best chance of success, and though I have experimented a little in other directions, my investigations have been practically limited to this one reäction.

It is essential that the jelly tested be thoroughly filtered, so the precautions taken by the jam-faker to avoid detection are helpful rather than otherwise for our present purpose. Any fibres or vegetable *débris* in the jam affect the regular deposition of the precipitates. A convenient amount of jam for a test is thirty grammes, which should be dissolved in about three hundred cubic centimetres of hot distilled water. Dissolution is best performed in a flask in which the mixture can be boiled. The solution should be filtered whilst hot, by means of a suction filter, and the bright solution of jelly concentrated by heating until a standard boiling-point is reached: 225° F. is convenient. The weight of jelly is now taken, and enough potassium iodide is added thereto to make a five per cent. solution of the salt. In practice it is more convenient to add the potassium iodide in the form of a twenty per cent. solution, rather than try to dissolve the crystals in the jelly direct. Assuming that a solution is used, the correct proportion is mixed in with the jelly, which is reboiled to the standard temperature and then poured out into test tubes. Two inches of jelly in each tube will suffice.

Having reached this stage, it is better to defer the next operation—the introduction to the tubes of a twenty per cent. solution of lead nitrate—until the following day, in order that the jelly may set thoroughly. In the case of strawberry a delay of several days is desirable, in order to give the surface time to harden a little, otherwise the skin of the jelly will be broken, and the lead nitrate solution mechanically mixed, instead of diffused, in the upper part of the jelly. Another way of dealing with a tender jelly is to cover it with a thin layer of a stronger jelly. I have successfully used glycerin jelly for this purpose. This plan should only be regarded as a *pis aller*: the introduction into the test of a foreign colloid must be considered undesirable.

A few tests made in this way are shown in Figure 174. Reading from left to right, they are apple, apple and gooseberry (equal parts), gooseberry, loganberry, and raspberry jellies. Apple jelly shows little or no tendency to yield the layers of lead iodide precipitates, which are a common feature in this branch of research. Layers are numerous in gooseberry, and, as might be expected, this formation

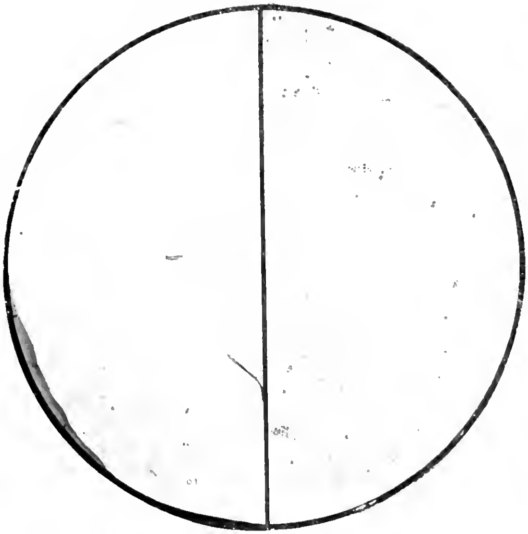


FIGURE 17[illegible]. Comparison [illegible] and [illegible] [illegible]

FIGURE 172. Raspberry [illegible] [illegible] [illegible] [illegible] [illegible] 200.

FIGURE 173. Raspberry [illegible] agar, lead [illegible] [illegible]

FIGURE [illegible] Ra[illegible]

A B C D E

FIGURE 174. Lead iodide reaction in filtered jams. (A) apple, (B) apple and gooseberry, (C) gooseberry, (D) logan, and (E) raspberry.

FIGURE 175. Apple.

FIGURE 176. Gooseberry with apple.

FIGURE 177. Gooseberry.

Lead iodide aggregates from test tubes. × 100.

can be traced in the apple and gooseberry mixture. Stratification is visible in loganberry, whilst in raspberry it is strongly marked, and the inter-spaces are unusually clear. Visual examination of the test tubes is secondary in importance to a microscopical examination of the deposits.

The largest aggregates are found low down in the tube in the interspaces, the layers being composed of small bodies closely packed. To obtain the large aggregates undamaged, I break the tube: suitable portions are then taken with a knife, and mounted in a thin tin cell, using the jelly as a medium. The cell is fastened to the slip with marine glue, and a coating of the same cement is applied to the upper surface of the cell; a drop of the jelly containing the aggregates is placed in the cell, and a cover-glass on top of it. The slip is then held, face downwards, over a spirit lamp until the moisture, which condenses on the glass in a cloud, has just cleared, when the slide is sealed by pressing it, face down, against a piece of tissue paper placed on a flat surface, such as a sheet of glass.

For the microscopical examination of these slides, I find nothing better than a one-inch objective and a Lieberkuhn. The aggregates are too opaque to be viewed by transmitted light, only their outlines being apparent, but dark-ground illumination is quite feasible. Aggregates of lead iodide formed in fruit jellies are shown in Figures 175–177. The specimens were obtained from the first three tubes in Figure 174. Apple shows rounded groups of smaller spheres. In gooseberry the groups are more irregular, generally three- or four-lobed, and seem to be built up of flat discs. In apple and gooseberry the nodules are intermediate, but I cannot claim that they have marked characteristics: they seem, perhaps, more to favour the apple type.

In colloid bodies, such as gelatine, agar-agar, or starch gels, the lead iodide reäction in test tubes is not long in reaching the stage when the results can be usefully examined—a week will generally suffice—but the addition or presence of sugar inconveniently delays matters. A fruit jelly may take six or eight weeks before it is ripe for examination. It occurred to me that by carrying out the tests in microscope slides a complete record of all stages of the reäction might be obtained in a convenient shape. Upon experimenting in this direction it was found that this plan gave results in a few hours, instead of days or weeks, though I am afraid that the aggregates in the confined space of a microscope slide cannot assume such characteristic forms as those grown without restriction.

The jelly to be tested is prepared in the same way as for tube tests. I generally employ the small surplus left after filling the test tubes for making three or four slides. A drop of the jelly is placed on the centre of a clean slip, and a thin three-quarter-inch cover-glass is placed upon the jelly. The slip is next held over a spirit lamp until the jelly begins to boil. The slip is then placed on the table, and the cover-glass pressed down with a five-eighth-inch cork, and held until all bubbling has ceased, and the slide has cooled. The preparation should now be transparent and free from bubbles, and with a surplus ring of jelly round the outside of the cover-glass. After a fifteen or thirty minutes' rest, the slide is placed in a bath of ten per cent. lead nitrate. The surplus unprotected jelly turns yellow at once, and gradually the formation of lead iodide proceeds inwards under the cover-glass. If all goes well, the action proceeds with perfect regularity, and may be stopped in about eighteen hours. It is undesirable to leave a slide in the bath too long, as it is more difficult to seal up afterwards. There should be a circular area in the middle of the slide, of about one-eighth of an inch in diameter, free from the yellow deposit. Figure 173 is a particularly fine example. Sometimes irregular action takes place (in tubes as well as slides); instead of concentric markings, we get opaque masses and broken curves. Tender jellies, such as strawberry, are prone to give trouble in this way. Two preventive measures may be taken: enough jelly should be put on the slip at the outset to ensure a surplus all round the cover-glass (too much is messy, but does no harm, too little is likely to cause trouble); or, secondly, the jelly may be taken to a higher temperature. A pure strawberry jam would require boiling to 230°, whilst an "improved" jam, containing gooseberry or apple, gives no trouble at 225°. The boiling-point of a jam containing agar-agar is lower still.

When the reäction in the slide has proceeded far enough, the slide is taken out of the bath, its surplus jelly carefully removed with a brush, rinsed in distilled water, and dried quickly. It is then promptly ringed with old gold size on a turntable, great care being taken to avoid touching the cover glass with the brush, whilst the size must flow right up to and embrace the edge of the cover. When the size is dry another coat should be applied, this time going over the edge of the cover. A coat or two of enamel and a final application of gold size will make the mount firm enough to clean without damage to the preparation. Care must be used, as pressure on the cover-glass will break the larger aggregates, especially when they are spherical in form, as in the case of pure raspberry. A slide of raspberry jam prepared in this way is shown, slightly magnified, in Figure 167. For making records of complete slides I use a two-inch Aldis photomicrographic lens in the camera.

Here, as with test tubes, the larger particles are found in the interspaces. The aggregates in slides are, however, so thin that they can be examined in the microscope by transmitted light, or, in fact, any other method of illumination. The formations are minute, and require a higher magnification to record them. Our illustrations record tests of raspberry jams, one pure and two adulterated. The first, Figure 167, is a pure jam: the layers are strongly marked, and larger individual

aggregates are rounded and opaque. Figure 172 is a raspberry and apple jam (otherwise an "improved" raspberry jam), and twenty-five per cent. of the fruit content is apple juice. The jam is so well prepared that the microscope alone does not reveal the adulterant. Here the layers consist of a cloud of minute particles, whilst the aggregates are translucent discs; only here and there can the opaque form be discovered. Lastly, in Figure 171, we have a raspberry jam with a minute trace of agar-agar, one part in five hundred. The formation of layers, though discernible under the microscope, is barely noticeable in the small area reproduced, whilst the appearance of the aggregates is different from the other examples.

It is necessary to bring considerable experience to the interpretation of the tests outlined above; even then it is improbable that small percentages of adulterants could be detected and accurately determined without far more care and attention than I have been able to bestow upon these investigations. If, however, it is possible by this means to detect large admixtures of filtered jellies, an important advance in the analysis of jams has been made. It is confessedly impossible to-day to tell whether or not a red currant jelly is pure; if filtration has been thorough the microscope reveals nothing, and the analyst can only report that he finds no evidence of the introduction of other fruit. Colloidal investigations should indicate the presence of gooseberry or apple in most commercial jellies.

It is desirable that other reäctions should receive careful attention; it is conceivable that a certain reäction may give particularly characteristic aggregates with one jelly, and so lead to its easy detection as an adulterant.

SOLAR DISTURBANCES DURING MARCH, 1914.

By FRANK C. DENNETT.

MARCH, notwithstanding the great amount of cloud and wet, has proved of interest to the solar observer. Four days (4th, 5th, 8th, and 13th) were missed altogether. On nine (1st, to 3rd, 7th, 9th, 19th, 20th, 25th, and 26th) the disc appeared free from disturbance, bright or dark; nine others yielded faculae, and spots were present on the remaining nine. The central meridian at noon on March 1st was 171° 43′. From the high latitude of one disturbance it has been found necessary to widen the chart this month.

No. 2.—Two pores, the larger preceding, and having a faculic edge, the other amid a faculic cloud. First seen March 12th, advancing from the north-eastern limb, the leader about four thousand miles in diameter. One of the pores, very small, continued until the 16th.

No. 3.—Interesting from its high northern latitude. Broke out on the 15th, a small spot with one pore just in front, and another behind it, whilst two more spotlets were at the rear, making the disturbance thirty-seven thousand miles in length. On the 16th and 17th the eastern spot was much the largest, being about seven thousand miles in diameter. When last seen, on the 18th, another smaller spot had opened in the rear of the large spot.

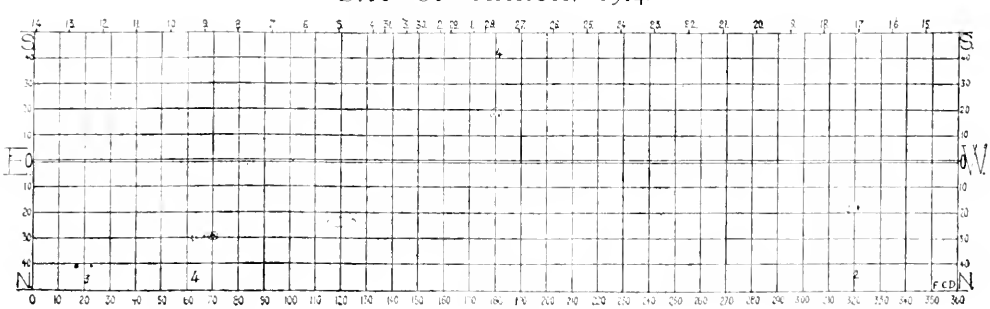
No. 4.—Two pores in a faculic area in southern latitude, near the south-eastern limb; seen only on March 22nd.

No. 5.—The finest disturbance since 1910. On 30th a spot, twenty-five thousand miles in diameter, was visible close to the north-eastern limb. Next day several smaller spots had come into view in its rear, and a bright tongue penetrated into its umbra from the north. Not much change was seen on April 1st; but on the 2nd the great spot had become doubled, and on the 3rd had split apart, the distance widening until the group, on the 6th, was composed of a leader, with bright-bridged umbra, 12,500 miles in diameter, and a rear spot with two larger and some smaller umbrae, twenty-five thousand miles in diameter, and penumbral streaks with small umbrae between, the whole sixty-eight thousand miles in length. Subsequently, the rear spot broke up, and the individual members of the group seemed dwindling as they approached the limb, round which it was lost on April 12th, a small spotlet being visible amid faculic disturbance.

Faculae were visible near the eastern limb on March 6th, and near the South Pole on the 10th and 11th, and also on the later date north-east, a disturbance amid which No. 2 broke out. Faculae were visible near the south-eastern limb on 21st, 23rd, and 24th. On March 27th to 29th a fine faculic area was near the north-eastern limb, shown around longitude 120° on the chart, and on the 29th some faculae also visible in the south-west.

Our chart is constructed from the combined observations of Messrs. J. McHaig, A. A. Buss, J. C. Simpson, E. E. Peacock, and the writer.

DAY OF MARCH, 1914.



METEORS.

By THE REV. M. DAVIDSON, B.A., B.Sc., F.R.A.S.

THE study of meteoric phenomena is an interesting one, offering to the amateur an introduction to more important work in other branches of astronomy. On any clear night a watch conducted for only a short period is certain to be rewarded by the appearance of a number of meteors, darting about in different parts of the heavens and in various directions. If the observer be fortunate enough to possess a celestial globe, he will find it useful to trace out their apparent paths in a backward sense; that is, by drawing with a soft pencil great circles on the globe from the *beginning* of the path in a direction *away from* the end. If a globe be not available, a star-chart may be used, but is not so valuable in the results.

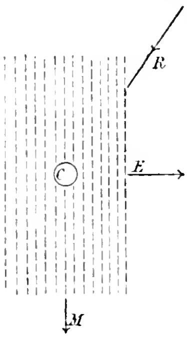


FIGURE 178.

Should the meteors observed belong to a definite shower, say the Lyrids, it will be noticed that the paths traced backwards appear to converge into a small area, to which the name "radiant" is applied. If they belong to no definite shower, but are "sporadic"—that is, coming from various parts of the celestial sphere, and quite unconnected—no such convergence is noticeable, the lines pencilled out showing no tendency to meet in a point or a small area. In what follows we shall try to show the difference between these types of meteors, and also the reason why the paths traced backwards converge towards the "radiant" in the case of the definite showers.

If we consider a meteor stream—say the Lyrids, Perseids, Leonids, and so on—we must remember that the width may be many millions of miles, and that the Earth, moving above a million and a half miles a day, would remain in the stream for several days, or, as in the case of the Perseids, much longer. Referring to Figure 178 this will be more clearly understood. The vertical lines represent the paths of the myriads of meteoric particles: each separate particle is shown by the short lines into which the longer ones are divided. The fourteen vertical lines are parallel, and approximately represent the manner in which the meteor streams pursue their paths through space, moving in orbits around the Sun, the different particles at any portion of the orbit moving in nearly parallel directions. The Earth is moving in the direction indicated by the horizontal arrow, so that there are two velocities to consider: (*a*) The velocity of the meteor stream in the direction marked M; (*b*) the velocity of the Earth. By combining these two, the velocity of the meteor particles being about $\sqrt{2}$ that of the Earth, the actual direction from which the meteors appear to come is that of the line marked R: this is their direction relative to the Earth, and the prolongation of this line backwards to meet the celestial sphere determines the radiant.

In Figure 180, let C_1, C_2, C_3, C_4, be layers of atmosphere at various heights, and P an observer on the surface of the Earth, denoted by a circle whose centre is C. Take BACF to be the celestial sphere, and assume that the plane of the paper represents a plane through the centre of the Earth and the observer, intersecting the meteor stream in the parallel lines aa′, bb′, cc′. We assume that these last three lines represent the *relative* motion of the meteor particles, that is, the motion obtained by combining the velocities of the Earth and the meteors. The atmospheric dimensions are considerably exaggerated, so that the results may be seen more clearly.

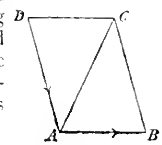


FIGURE 179.

Now consider a particle moving in the direction aa′ relative to the Earth, its appearance being at a, where it encounters the layer C_1, and its end being at a′ in the layer C_2. An observer at P sees its path projected on the celestial sphere, and its apparent path is AA′. The other particles bb′ and cc′ can be similarly treated, the observer seeing them apparently moving along portions of the celestial sphere BB′, CC′ respectively, the assumption being that they become luminous at b and c, and disappear at b′ and c′ respectively. We may remark in passing that the heights at which meteors appear and disappear are very various, so that the reader will see the justification for taking different atmospheric layers into consideration.

At first sight there appears to be little connection between the paths AA′, BB′, and CC′, but these paths produced backwards converge to the radiant marked R in the figure. It is easy to see what is implied by the radiant. The three parallel lines

a′a, b′b, and c′c, if produced to infinity, meet at a point R on the celestial sphere, and it is from this point that the streams of meteors, moving in parallel lines, appear to come. The fact that we know the velocity of a meteor with reference to the velocity of the Earth, and also the resultant direction obtained by combining the two, gives us the first step in finding the orbit of a meteor stream (on which we hope to say something in a future article). Thus, by referring to Figure 178, if we know the direction of the line R, which is the direction of the resultant velocity, and also the ratio between

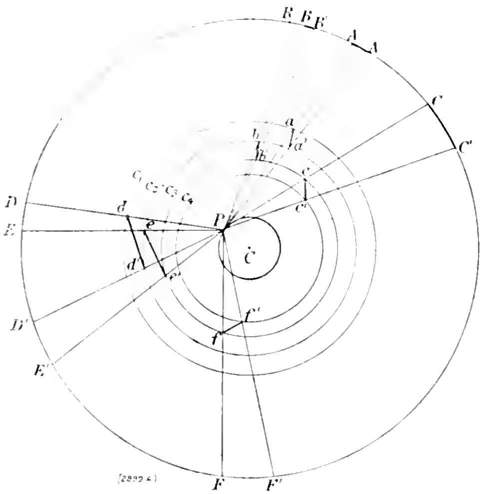


Figure 180.

the velocities of the Earth and the meteors, generally about $1 : \sqrt{2}$, we can at once determine the true direction, M, of the motion of the stream, since we know the point towards which the Earth is moving at the time. The determination of the direction of M gives us the tangent to the meteor stream at the point of intersection of the Earth's orbit, and from this it is possible to find the elements of the orbit of the meteor stream.

Now let us consider the relative paths of three other particles which are not connected with any definite stream, such as dd′, ee′, ff′. Using the same reasoning as before, an observer at P would see their apparent paths along the portions of the celestial sphere marked DD′, EE′, FF′ respectively. In this case these arcs will not meet in a point, as there is no definite radiant, the meteors being known as "sporadic." We have represented the phenomena of meteor motion in one plane for the sake of simplicity, but it is easily seen how the argument would apply if the atmospheric strata and the heavens be taken, as they should be, not as circles, but as concentric spheres. Those who possess a celestial globe can follow the reasoning more easily by imagining an observer at the centre of the globe, atmospheric layers arranged in small spheres around him, and the apparent paths of a meteor shower traced upon the surface of the globe which represents the celestial sphere.

We may refer to Figure 180 for an explanation of the fact that long-pathed meteors are generally far from the radiant, and that short-pathed meteors are, as a rule, near the radiant. Consider the flight bb′: its projection, BB′, is rather a short path; the projection of aa′ is longer, and that of cc′ longer still, although the actual lengths of the paths aa′, bb′, cc′, are nearly the same. It is easy to see that the closer a meteor is to the radiant the shorter is its path, and, indeed, if a meteor is seen to be stationary, appearing like a flash, but without moving over any arc on the celestial sphere, we know that its radiant is where it appears. Thus, if a meteor belonging to the shower which we are considering appeared at R as a flash, we should feel justified in saying that its motion was in a direction from R to P, where P still represents the observer, and also that R was its radiant. A familiar instance will explain this more fully. Suppose on some night that the lights of a motor-car are observed at a distance of, say, one mile, and that the motor-car is moving athwart our line of sight. There would be no difficulty in recognising the motion; we should simply refer the lights of the car to some stationary objects, say street lamps in the distance. But if the car is coming straight towards us, we should not easily recognise that it was moving; the lights might appear to be stationary. The slightest deviation from the line drawn between the observer and the car would be noticed after a time, and the greater this deviation, the faster is the apparent motion of the car.

This illustration will make clear the fact that a meteor may have quite a long path in the atmosphere, and yet its apparent path may be very much shortened, or it may appear like a flash, if it is moving nearly in a line towards the observer.

Having determined the radiant, the relative velocity with which the meteors enter our atmosphere can be easily found. First of all, we must know to what part of the heavens the Earth is moving at the time. This is easily found when we remember that the orbit of the Earth is nearly circular, and therefore the direction of the motion at any instant is very nearly perpendicular to the line joining the Earth and the Sun. If we deduct 90° from the longitude of the Sun, we obtain the point on the ecliptic towards which the Earth is moving at the instant: this point is known as the "Apex of the Earth's Way." Although this method does not give it exactly, nevertheless it is approximate enough for the present purpose, the error never amounting to 1°. Knowing the direction of the Earth's motion and the apparent

direction of motion of the meteor stream, denoted by R in Figure 178, we can easily find the true direction, M, of the meteor stream by means of the parallelogram of velocities. The angle ECR is known as the apparent elongation of the radiant from the apex of the Earth's way, and the first step is to find its value. The following simple formula will be found useful for this purpose, and can be easily applied by the general reader:—

If l be the longitude and b the latitude of the radiant, λ the longitude of the apex of the Earth's way, and ϵ the apparent elongation of the radiant from the apex of the Earth's way,

$$\cos \epsilon = \cos b \cos(l - \lambda).$$

Thus, if the longitude of the Sun is 166°·8, we may take λ to be 76°·8. If $l = 131°·5$, and $b = 23°$, we have $\cos \epsilon = \cos 23° \cos 54°·7$, or $\epsilon = 57°·9$. It should be noticed that ϵ can have all values from 0° to 180°, and that attention must be given to the sign on the right side of the equation. Thus, if $\lambda = 106°$, $l = 305°$, $b = 3°·5$, then $l - \lambda = 199°$, and $\cos \epsilon = \cos 3°·5 \cos 199° = -·9437$.

$$\therefore \epsilon = 180 - 19°·3 = 160°·7.$$

In Figure 179 let AB represent the velocity of the

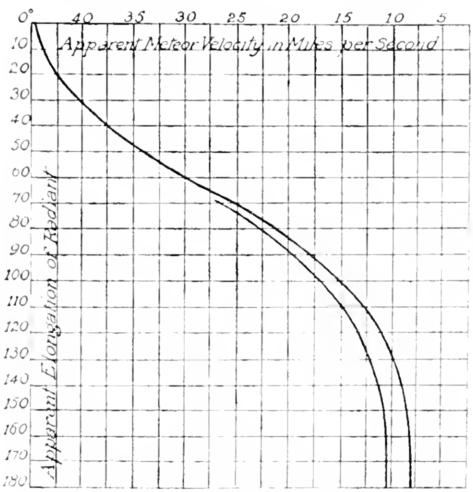


FIGURE 181.

Earth in magnitude and direction, and DA that of the meteor in magnitude and direction. Complete the parallelogram and join CA. This line will represent the velocity of the meteor, relative to the Earth, in magnitude and direction.

The angle CAB is the apparent elongation of the radiant, which we denote by ϵ. Let the angle DAB be ϵ'; then $\dfrac{CA}{AB} = \dfrac{\sin CBA}{\sin ACB} = \dfrac{\sin \epsilon'}{\sin(\epsilon' - \epsilon)}$

or $$CA = AB \frac{\sin \epsilon'}{\sin(\epsilon' - \epsilon)}.$$

Now, in the case of meteor streams, we assume that they are moving around the Sun with parabolic velocity, so that the velocity of the meteors is $\sqrt{2}$, if that of the Earth is 1. From the triangle CAB, $\dfrac{AB}{BC} = \dfrac{\sin(\epsilon' - \epsilon)}{\sin \epsilon}$, or $\sin(\epsilon' - \epsilon) = \dfrac{1}{\sqrt{2}} \sin \epsilon$, from which $\epsilon' - \epsilon$, and therefore ϵ' can be found.

Hence, $CA = AB \cdot \dfrac{\sqrt{2} \sin \epsilon'}{\sin \epsilon}$. As AB represents the orbital velocity of the Earth, about 18·47 miles a second, the relative velocity with which a meteor enters our atmosphere is $18·47 \sqrt{2} \dfrac{\sin \epsilon'}{\sin \epsilon}$. One example will make this clear. If $\epsilon = 63°$, the equation $\sin(\epsilon' - \epsilon) = \dfrac{1}{\sqrt{2}} \sin \epsilon$ gives $\epsilon' - \epsilon = 39°$, or $\epsilon' = 102°$. Hence, the relative velocity of approach to the Earth is $18·47 \sqrt{2} \dfrac{\sin 102°}{\sin 63°} = 28·67$ miles a second.

The accompanying graph (see Figure 181) shows the relative velocities for various elongations of the radiant. There is another graph which gives higher velocities: this latter is constructed by allowing for the increased velocity of a meteor caused by the attraction of the Earth. For low velocities the two differ by nearly three miles, but as the velocities increase this difference becomes smaller, until an elongation of 0° is reached, when the difference is a little over half a mile. The increased velocity V, say, can be found from the unaccelerated velocity, v, by the formula $V^2 = v^2 + 49$. The graphs explain themselves. Thus, for an apparent elongation of 130°, the accelerated velocity reads just under 12·5, and the unaccelerated velocity 10 miles a second. The graph for the higher velocities has not been continued beyond an apparent elongation of 70°, as the two curves would approach very closely, so that it would be difficult to distinguish between them.

Figures 178 to 180 are reproduced by kind permission of the Council of the British Astronomical Association

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

MARS.—*Popular Astronomy* for recent months has contained an interesting series of articles on Mars by Professor W. H. Pickering, who has been in charge of an expedition from Harvard College to Mandeville, Jamaica (altitude, two thousand one hundred feet) to observe the recent apparition with an eleven-inch Clark refractor. He refers to the enormous scale on which inundation from snow-melting takes place in Siberia, where vast tracts are converted into semi-lakes, and thinks that the appearances round the melting Martian snow-caps can be explained by a similar phenomenon.

Observations were begun on July 27th, over five months before opposition. No snow was then visible on the disc, the south polar regions being reddish and free from snow or cloud. The North Pole was 10° below the horizon, but the edge of the cloud-cap surrounding it could be seen. Snow was seen in September round both poles, the northern cap being two thousand three hundred miles across. On August 14th there was an unusual amount of cloud on the disc, four-tenths of it being covered.

The dark zone surrounding the northern snow became visible, and afterwards the darkening extended to Ganges and Aurorae Sinus, suggesting, according to Professor Pickering, the transference of moisture.

On October 19th it is noted that Solis Lacus and Lacus Phoenicis were invisible, though near the central meridian. It is distinctly noted that the dark band round the north polar cap was not visible when the snow was first seen, but increased rapidly in intensity. It was irregular in width, being chiefly concentrated in four knots, one of which found the head of the Canal Amenthes; another was the Acidalium Mare. A broad, dark band reached from this to the Equator. Great changes of shape could be detected in some of the well-known markings. Thus the zero meridian, Fastigium Aryn, could not be distinguished at the end of 1913, the two bays running together and forming a semi-circular knob corresponding to the aspect in a drawing by Beer and Mädler in 1830. Sabaeus Sinus and Margaritifer Sinus were observed to grow towards the north at the rate of four miles per hour. They were of a different tone from Mare Acidalium, which was blue, and is supposed to have been a plain covered with shallow water.

Two bays, resembling Margaritifer, developed suddenly about December 16th in longitudes 185° and 160°. Measures of the polar cap indicate that, when melting, its edge retreated one hundred miles per day. This indicates that the layer of snow or ice is thin, but not a mere film of hoar-frost, since that would disappear simultaneously over immense areas, and not show a definite retreat. A layer of snow, of gradually increasing thickness, seems to be indicated.

The north polar cap attained its greatest development on November 2nd, "corresponding to the equivalent date of March 5th of the terrestrial year," when its boundary lay in latitude 57° on the average, but extended to 42° in some parts. The dark band round the cap reached its maximum breadth of 25° in the first half of November.

The general result of the report is to increase our estimate of the prevalence of cloud on the planet, and to make it probable that a considerable amount of moisture is precipitated as rain or snow. Also some of the well-known outlines of the planet are shown to be subject to large fluctuations, partly arising from obscuration by cloud, but partly of a real objective character.

Both Professors Pickering and Lowell have found that the zero meridian (Fastigium Aryn) passes the centre of the disc ten or twelve minutes before the time given in the Almanac. The latter uses the period of rotation $24^h 37^m 22^s{\cdot}65$, and the time of passage of the zero meridian was adjusted about 1894 to agree with Lowell's observations.

Hence the error of the adopted period would be 10^m in twenty years, or $\frac{1}{2}^m$ per year, or $^s{\cdot}08$ per rotation, which would make $24^h 37^m 22^s{\cdot}57$. It will be remembered that Kaiser found $22^s{\cdot}62$ for the seconds, but Proctor pointed out some numerical mistakes in his work. In spite of these Kaiser's result appears to be nearer the truth than that of Proctor, who found $22^s{\cdot}72$ for the seconds. Kaiser's value was confirmed by Marth, who worked from Maraldi's drawings of 1704, and found $22^s{\cdot}626$. It seems to me that both Kaiser and Proctor exaggerated the accuracy of the very rough drawings of the seventeenth century. It is a truism that an equally good rotation period can be derived from an interval one-quarter of the length used by Proctor provided that the accuracy of the drawing is four times as great. I question whether it is wise to go further back than the numerous drawings of Sir W. Herschel, made in 1783. It would be a good piece of work for anyone with the necessary leisure to rediscuss these drawings, combined with accurately timed modern ones, and deduce a new rotation period. Even a shorter interval might yield useful results. Half a century has now passed since the beautiful and accurate drawings of Rev. W. R. Dawes were made. However, what is required for this purpose is not an elaborate drawing of the whole visible disc, which must take a considerable time to execute, so that one is doubtful whether the time affixed to the drawing is that corresponding to the execution of the particular feature discussed. What would be of more value would be a note of the passage of some well-known feature over the central meridian, but unfortunately such observations are exceedingly scanty. Let observers put a considerable number of them on record, so that they may be utilised in coming years.

COMETS.—The interesting comet of Delavan was observed in March, but by the time these notes appear it will be lost in the Sun's rays, to reäppear in July in the morning sky, when it should be much brighter.

The first comet of 1914 was discovered by Herr Kritzinger of Bothkamp on March 29th. The following orbit is by Dr. Kobold from observations on March 29th, 30th, and 31st :—

$$\begin{aligned} T &= 1914,\ \text{May } 31{\cdot}14 \text{ G.M.T.} \\ \omega &= 67^\circ\ 1'. \\ \Omega &= 198^\circ\ 37'. \\ i &= 23^\circ\ 31'. \\ \text{Log. } q &= 0{\cdot}0991 \end{aligned}$$

Ephemeris for 11 p.m.

	R.A.	N.Dec.	Log r.	Log. Δ
May 6	$18^h 31^m 14^s$	20° 49′	0·1178	9·7130
,, 14	19 3 26	27 27	0·1080	9·7154
,, 22	19 34 56	32 55	0·1015	9·7275
,, 30	20 5 26	37 13	0·0992	9·7456

The comet will be due south during May, about 3 a.m., and will be readily observable before midnight. It should be a conspicuous telescopic object when the Moon is absent. It is nearest the Earth on May 9th, the distance being 0·5154 in astronomical units.

THE NAUTICAL ALMANAC FOR 1916.—The chief feature of present interest in this volume, which has just been issued, is the path of the shadow in the total solar eclipse of February 3rd. The shadow will not fall on any

part of the Azores, but passes some seven miles to the north-west of Corvo. Those who wish to see the eclipse from land will have to go to Guadaloupe, or South America (north coast). It is noteworthy that the shadow track passes nearer our shores than has been the case for a long time. A voyage of one hundred and fifty miles west of the Scilly Isles will suffice to see the sun set totally eclipsed; it will, however, be necessary to go several hundred miles further west to obtain a sufficiently high Sun to permit a view of the corona. It is likely that several Atlantic liners may slightly modify their course so as to come within the shadow track.

BOTANY.

By PROFESSOR F. CAVERS, D.SC., F.L.S

THE PURPLE SULPHUR-BACTERIA.—M. Skene (*New Phytologist*, 1914) has made an investigation of some members of the remarkable group of Schizomycetes included under the name "sulphur bacteria." These bacteria are capable of oxidising sulphur or one of its unoxidised compounds, producing in some cases sulphur, and in others sulphuric acid, and they are divided into two main series. To the first series belong those which resemble ordinary bacteria in form, and do not store up sulphur internally; such are the Thiobacilli, which oxidise thiosulphates to sulphur or sulphuric acid, and thus obtain energy which they expend on the reduction of carbon dioxide; hence they are "autotrophic" in the sense that they do not, like most bacteria, require carbon in an organic form. The second series includes a number of forms which oxidise sulphuretted hydrogen to sulphuric acid. The process takes place in two stages, sulphur being first formed and stored inside the cells as globular masses, which are then further oxidised. Of the sulphur-storing forms there are two kinds: (1) Colourless forms like *Beggiatoa* and *Thiothrix*, which have been recently shown to be autotrophic; and (2) forms possessing a red pigment, the so-called purple sulphur bacteria, with which Skene's paper is specially concerned.

These forms (*Chromatium, Lamprocystis, Amoebobacter, Thiopolycoccus, Thiothece*) occur in stagnant water, and, though not very common, they sometimes occur in such masses as to colour the water or mud bright-red or purplish; hence they have been frequently investigated. The writer, who worked chiefly with *Amoebobacter roseus* and *Lamprocystis roseo-persicina*, gives details of his methods of culture, compares his results with those of earlier observers, and summarises his work as follows: The attempts made to obtain pure cultures of purple sulphur bacteria were without success. In mixed cultures *Amoebobacter* (and probably also *Lamprocystis*) thrives best in a mineral solution containing ammonium sulphate as a source of nitrogen, and with chalk as a neutralising agent. All the organic sources of nitrogen and carbon which were investigated proved to be without favourable influence on the growth of the bacteria; indeed, as a rule, they tend to inhibit development. Development can only take place in the presence of hydrogen sulphide, which cannot be replaced by other sulphur compounds. Growth takes place only in light, red light being more effective than blue. The purple sulphur bacteria require free oxygen, which is probably supplied in nature by associated green organisms.

THE ORIGIN OF FLOWERING PLANTS.—In a paper on the development of the stamens, ovules, and embryo of the Magnoliaceae, Maneval (*Bot. Gaz.*, 1914) brings together a very useful summary of the various theories that have been put forward regarding the origin of the higher flowering plants, or Angiosperms. After pointing out the general agreement among botanists that the Dicotyledons are more primitive than, and have given rise to, the Monocotyledons, he considers the question of the primitiveness of various features among the Dicotyledons themselves. The present theories are fairly represented by the views of Wettstein on the one hand and those of Arber and Parkin on the other. Both theories agree in deriving Angiosperms from Gymnosperms, and Monocotyledons from Dicotyledons. Wettstein considers that the following are primitive characters for Angiosperms: Prevalence of woody plants and absence of vessels in the vascular bundles; prevalence of unisexual flowers, with either no perianth (sepals or petals) or one of simple structure; prevalence of anemophily (wind-pollination). These are Gymnosperm characters; hence Wettstein holds that we should regard that group of Angiosperms as most primitive which shows these characters developed in a high degree. Arber and Parkin give a longer list of characters which they believe are primitive: on their view, regular and bisexual flowers, entomophilous (insect-pollinated), with an elongated axis bearing a well-developed petaloid perianth and numerous free spirally arranged stamens and carpels, are primitive. If it be granted that all the essential characters that can be regarded as primitive are included in these lists, then it is evident that the chief differences between the two theories relate to but a few points—points, however, which involve no end of difficulty. The two theories would practically be reduced to one if we could say which of the following are primitive, unisexual or bisexual flowers, presence or absence of a perianth, anemophily or entomophily. The fact that certain characters are common to all or nearly all Gymnosperms seems in many instances to be one of the strongest reasons for regarding these characters as primitive if they occur at all among Angiosperms. Among such supposedly primitive characters are dicotyledony of the embryo, prevalence of woody plants, and absence of true vessels (tracheae) from the conducting strands. For the same reason we might conclude that primitive Angiosperms were wind-pollinated, and possessed naked and unisexual flowers, since these characters also are common to most Gymnosperms. The striking resemblances in the essential organs of reproduction in Monocotyledons and Dicotyledons—particularly in such structures as the embryo-sac—makes it almost inconceivable that the two groups have had a separate origin, while the essential similarity in vegetative structure of all Dicotyledons (the important differences being merely in form and arrangement of the leaves and non-essential floral organs) makes it equally likely that this group arose from a single stock. If this be granted the questions arise: "Which Dicotyledons are the most primitive?" and "From what particular stock of Gymnosperms have they come?" As regards the latter question, the Gnetales, and more recently the extinct Bennettitales, have been regarded as the source of the Angiosperms; but opinions differ as to which is the parent group, according to whether one regards naked unisexual anemophilous flowers, or entomophilous bisexual ones with a perianth, as primitive. Insect-pollination is clearly associated with much of the evolution of Angiosperms, but it does not necessarily follow that primitive Angiosperms were entomophilous. That anemophilous Angiosperms may succeed and persist in competition with entomophilous forms is well illustrated by such groups as the grasses and the catkin-bearing trees.

Few botanists believe that the flower of any existing Angiosperm is like the primitive Angiospermous flower; whether the latter was unisexual or bisexual it does not follow, though this is quite possible, that any particular flower of to-day is the direct descendant of a similar type in its ancestor. It is certain that in many instances bisexual flowers have become unisexual, and that perianths have been more or less completely lost. That the opposite may have occurred is less easily proved. Whatever view is taken, the origin of the perianth remains at present a mystery, and it may have been developed among Angiosperms long after they had become a distinct group of plants. The question whether primitive Angiosperms had unisexual or bisexual flowers presents quite as great difficulties as that concerning the primitiveness of the perianth. Evidence from Gymnosperms that bisexual flowers are primitive rests almost

entirely on a single extinct and much specialised group, the Bennettitales, which many regard as representing the end of a distinct line of Gymnosperm development. The resemblance of the Bennettites cone to a flower like that of Magnolia is remarkable, but it has been suggested that the Bennettites "flower" is really an inflorescence, or group of flowers, and if the Magnolia flower is not compound the resemblance becomes only a superficial one.

Although bisexual flowers occur in *Welwitschia*, one of the Gnetales—which have in some respects developed along parallel lines with the Angiosperms, *e.g.*, in having true vessels—the Gnetales can hardly be regarded as actual transition forms leading to Angiosperms, though this does not preclude the possibility of common ancestry in the distant past. The Gnetales most likely represent the end of a Gymnosperm line just as the Bennettitales do; hence neither group represents the direct progenitors of Angiosperms.

All these considerations point to the conclusion that the ancestors of the Angiosperms in the remote past had naked unisexual flowers, but that among existing groups, bisexual flowers with a perianth are primitive, the naked unisexual forms (*e.g.*, the catkin-bearing families, or Amentiferae) having been secondarily derived from the latter: these forms, often considered as primitive, frequently have complex inflorescences; the ovary is prevailingly syncarpous, and there are other features that are certainly to be regarded as derived and not primitive.

The author is therefore led to conclude that the type of flower found in Magnoliaceae is the most primitive to be found in existing Angiosperms; that the Bennettitales, Gnetales, and Angiosperms may have had common ancestors if we go back to a time prior to that when the Bennettitales became a distinct line; and that Angiosperms were probably either derived from the same ancient fern stock from which the Cycadofilicales originated or were differentiated from that group at a very early time.

A HETEROSPOROUS FOSSIL FERN.—Lignier (*Mém. Soc. Linn. Normandie*, 1913) has described a new genus (*Mittagia*) from the Lower Westphalian strata, which is the first heterosporous fossil fern so far discovered. That such forms probably occurred might, of course, be expected from the existence in the Palaeozoic of the remarkable group Cycadofilicales (or Pteridosperms), which combine the characters of ferns and of seed-plants; but this is the first demonstration of their presence. Lignier at first thought his sections were those of the well-known Pteridosperm, *Lagenostoma Lomaxi*, the outer tissues of the sporangium being similar; but he found four megaspores to a sporangium, a stomium like that characteristic of fern sporangia, and the latter in a sorus, these features showing clearly that his plant was something very different from a Pteridosperm. Apparently the sporangium did not open, and thus represented a stage towards the seed habit. The author shows how this new fossil differs from anything hitherto found among the Equisetales, Lycopodiales, and Cycadofilicales, and his discovery appears to be one of the most interesting and important made in fossil botany for many years.

DIASTASE IN RED ALGAE.—In the Red Algae grains resembling in form, and probably in general composition, the starch grains of green plants are formed, though apparently they are not deposited in the plastids as in most starch-forming plants, but in the protoplasm outside the plastids, and often apparently quite independent of them. These grains in the Red Algae do not give the usual blue colour when treated with iodine, the colour in some cases being violet, but usually ranging from light brown to wine-red; indeed, so wide is the colour range that possibly each species will be found to give its own characteristic colour reäction with iodine. Various investigators have shown that these grains differ from ordinary starch further in resisting the action of malt extract, while the sugars they give on being treated with acids—galactose and fructose, besides glucose—differ from those yielded by ordinary starch. Since, however, the grains appear and disappear at various times during the life of the plant, it seems likely that, as in other plants, there is a ferment which brings about that decomposition. Bartholomew (*Bot. Gaz.*, 1914) has investigated the matter thoroughly, and has found that the Red Algae examined possess a diastase which is capable of digesting the starch of higher plants, but that the diastase of the Red Algae is probably not composed of a single ferment, but of a series of ferments (amylases which act on starches and dextrinases which act on dextrin); that, judging by the action of the algal extract upon corn starch, the diastase is a rather slow-working ferment; and that the series of digestion processes resulting from the application of the algal diastase to corn starch indicates that the substance composing the grains of the Red Algae is, after all, very similar to that of the starch grains of higher plants.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

PHENOMENA SHOWN BY ACTIVE NITROGEN.—In 1911 the Hon. R. J. Strutt described an active modification of nitrogen, an account of which was given in these columns at the time. On repeating his experiments, Messrs. Tiede and Domcke (*Ber. d. d. Chem. Ges.*, 1914, XLVII, 420) found that the after-glow of the active nitrogen that had been passed over heated copper was suppressed unless oxygen had been added to the nitrogen. In the opinion of these chemists, the phosphorescence of sulphur, iodine, sodium, and other bodies which occurs when they are heated in nitrogen, through which has been passed an electric discharge, must be attributed to the presence of oxygen, and not to the nitrogen having been rendered active. On the other hand, Messrs. Koenig and Elöd (*Ber. d. d. Chem. Ges.*, 1914, XLVII, 523) have proved that the after-glow will take place in nitrogen, free from every trace of oxygen, provided that metallic vapours, such as those of mercury, are also excluded. The glow is suppressed by the presence of a mere trace of mercury vapour, such as would be derived from the pump and manometer in the experiments of Messrs Tiede and Domcke. On admitting a little oxygen, this mercury is oxidised, and the glow reäppears, while the introduction of still more oxygen extinguishes it.

The conclusions of Mr. Strutt have also been confirmed by the work of M. J. Kowalski (*Comptes Rendus*, 1914, CLVIII, 625), who has obtained the same phenomena with nitrogen from which special precautions were taken to eliminate every trace of oxygen. The orange glow of the "active nitrogen" was preceded by a series of minute explosions and an intense violet fluorescence. The explosions were attributed to the interaction of the active nitrogen upon the mercury vapour, with the formation of an explosive mercury nitride. The presence of mercury vapour (derived from the pump) in the gas was proved spectroscopically, the violet light showing the spectrum of mercury.

BLUE PERCHROMIC ACID.—The acid corresponding to potassium bichromate was believed to be present in the blue liquid obtained by treating a solution of chromic acid (chromic anhydride) with hydrogen peroxide. By shaking the solution with ether a blue layer is produced, which is more stable than the blue coloration in the aqueous liquid. Until recently, all attempts to isolate this supposed perchromic acid proved fruitless, but it has now been separated as a deep blue crystalline mass by Messrs. Riesenfeld and Mau (*Ber. d. d. Chem. Ges.*, 1914, XLVII, 548). The method employed was to dissolve chromic acid (chromic anhydride) in methyl ether, and to treat the solution with concentrated hydrogen peroxide at a temperature of $-30°$ C. The composition of the acid agreed with the formula $H_3CrO_8 . 2H_2O$, and the following constitutional formula was suggested for the compound, since the water

present appeared to be not merely water of crystallisation:

$$Cr(OH)_4(O.OH)_3.$$

The composition of the acid did not vary with the amount of hydrogen peroxide used to produce it. At temperatures higher than −30° C. it decomposed, and this explains the failure of previous attempts to isolate it. Its strength as an acid was estimated to be about the same as that of acetic acid.

FERMENTATION AND THE RESPIRATION OF PLANTS.—The experiments of Dr. W. Palladin (*Biochem. Zeit.*, 1914, LX, 171) to ascertain the part played by water in the fermentation of sugar and the respiration of plants have given instructive results. It was not found possible to replace water by other solvents, such as glycerin or alcohol, without checking or inhibiting the action of the zymase (alcohol-producing enzyme) and the other enzymes of yeast. Water thus plays a part in alcoholic fermentation, and is probably the source of part, at least, of the oxygen liberated as carbon dioxide.

With regard to the respiration processes of higher plants, the conclusion is drawn that water is first assimilated, and that the oxygen required for the oxidation of the sugar (dextrose) in the plant is derived in equal proportions from this water and from the sugar itself, the whole of the carbon dioxide liberated being produced in the absence of air. The hydrogen thus set free from the water enters into combination with the respiration pigments, which are termed "hydrogen-acceptors," and the whole of the oxygen taken up by the plant in the respiration process is utilised in the oxidation of this combined hydrogen. The water formed in this oxidation is therefore of aërobic origin. This withdrawal of hydrogen from the pigment by the oxygen is effected through the agency of other enzymes, termed "peroxydases."

These views receive strong support from the experiments of Dr. Wieland upon the bacterial oxidation of alcohol into acetic acid, which pointed to the conclusion that the change was effected by oxygen derived, not from the air, but from water; while the atmospheric oxygen acted merely as an "acceptor" to combine with the hydrogen set free from the water.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

METALS IN WARSHIPS.—In his presidential address to the Institute of Metals Sir Henry J. Oram, Engineer-in-Chief of the Fleet, gave some interesting figures showing the proportions of non-ferrous metals and steel in the structure of the modern warship. Steel is employed wherever possible, with the result that in the newer ships there is not that wealth of copper, brass, gun-metal, and so on, which added so largely to the scrap value of the older ships. Yet, although the non-ferrous metals cannot usually compare with steel in structural strength, there are still many positions in which other qualities than strength are necessary, and in these positions the non-ferrous metals are still indispensable. Approximately for every hundred tons of iron and steel used in a modern warship there are six tons of copper or its alloys in a battleship, and eight tons in a cruiser, the difference being accounted for by the smaller proportionate amount of armour and the higher power of the cruiser. The propelling machinery of a modern battleship contains a weight of non-ferrous metals equal to seventeen per cent. of that of the contained steel and iron, while in a battleship of twenty years ago the proportion was as high as about thirty-four per cent. In the hull structure, as distinct from the propelling machinery, the proportion of non-ferrous metals shows a slight rise, being 4·4 per cent. of the iron and steel, as against 4·2 per cent. twenty years ago. Although here, also, steel has largely taken the place of non-ferrous alloys, the reduction has been counter-balanced by the considerable increase in gun-turrets and their machinery, fire-control appliances, electric lighting, telephones, and so on, where copper alloys are necessary.

LOCAL SURFACE-HARDENING OF HIGH-TENSILE STEELS.—The operation known as "case-hardening" consists in heating a mild-steel article surrounded with carbon or a suitable carbon-containing compound, so that the surface of the article becomes comparatively rich in carbon, and can be rendered very hard by quenching. Difficulties arise, however, unless the material is originally comparatively mild, and the process is not a convenient one when it is desired to harden only a relatively small portion of a given surface. Messrs. Vickers have now devised a process by which the surface of high-tensile steel may be hardened locally by simply heating the particular portion with an oxy-acetylene flame, using a welding burner, the body of the article being kept as cool as possible by immersion in water (*Engineering*, February 13th, 1914). The hottest possible flame is used, and is applied for a very short time only. Thus, in the case of a gear-wheel, the surface is traversed by the flame just as with a paint-brush. The intense heat and the rapidity with which this heat is transferred to the surface of the steel instantly cause the surface to be raised to hardening temperature. As the flame passes along, this surface is cooled by the cold remainder of the forging or casting, leaving the surface with the maximum hardness of which the steel is capable, when heated, and quenched in cold water. To obtain a thin but intensely hard surface, the part to be hardened should be just below the surface of the water, the impinging flame blowing the water away. The method involves no distortion of the mass, and does not destroy the effects of the usual heat treatment, to which the casting or forging as a whole may have been subjected.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

THE ECONOMIC VALUE OF TROPICAL RAINFALL.—M. G. Capus contributes an article on this subject to the *Annales de Géographie* for March last. The discussion is based on the study of the rainfall and on analyses of rain for Tonkin. The amount of nitrogen combined during thunderstorms as nitric acid and ammonia, and carried down in solution in rain, is much greater in Tonkin than in Europe. Nitrogen as nitric acid is equivalent to a mean of fifteen kilograms of sodium nitrate per hectare, and as ammonia to three to seven kilograms of ammonium sulphate. In the thirteen provinces constituting the delta of Tonkin the ground under rice must receive about seven million six hundred thousand francs' worth of chemical manure per annum, and the crops are able to use the salts to the value of about three million three hundred and twenty-five thousand francs. In Cochin China there are about one million five hundred thousand hectares under rice, and the climatic conditions are similar. In the flat land of the Tonkin delta the amount of run-off is low; accurate figures are not available, but the estimate of ten per cent. of the rainfall is adopted. Evaporation accounts for about half of the rainfall on the average, but at times considerably exceeds the actual amount of rain. The cultivated plots are in natural depressions traversed by *arroyos*, which never carry torrents of water. Rivers which are nourished by the precipitation on the mountains in the interior are often largely swollen, but the farmer sees them run, brimful of muddy water, uselessly past his parched and hardened fields. In this region, then, the engineer has splendid scope for his skill. Not only is it possible to husband the copious rainfall to supply the deficiencies of irrigation in times of drought, but the measures necessary for that will secure to the crops a superabundant supply of valuable fertilisers.

A RECENT LOWERING OF THE LEVEL OF THE CASPIAN SEA.—The same magazine contains an investigation of the fluctuations of the level of the Caspian Sea, in the period 1851-1912, by M. J. Schokalsky. There are

oscillations of the level of the lake of three kinds: (1) oscillations of short duration, with a period of a few hours; (2) non-periodic oscillations, due to winds; (3) annual oscillations. Variations of level of the first type can be explained as the phenomenon of *seiche*. They are variable in period and amplitude, as shown in the records of the tide gauge at Bakou. The non-periodic oscillations naturally vary at a given place with variation of the direction of the wind. The annual variations of level are similar at all the stations, with minor divergences in the northern and southern extremes in amplitude, and in the times of the annual maximum and minimum.

If the monthly variations of the level of the lake are examined, it is found that in the years 1910–1913 they exceed the means calculated on the data for the previous eighteen years. This is first observed in the variation for July, 1910, and there is a continual increase thereafter. In the three years this is seen in a progressive fall in the level of the lake, amounting to 21·1, 40·2, and 43·7 centimetres in the respective years. The figures are means of values for the stations of Bakou and Kououli. The fall could easily be explained if, as has been suggested, there had been subsidence of some considerable part of the lake-floor. But a study of the volume of water delivered by the main source of water supply to the Caspian, the river Volga, makes it seem probable that no such explanation is necessary. That river receives its main confluents above Samara and Tsaritsyn, for which places data are available. The means for the three years under consideration show that the volume of water carried past these stations has decreased by amounts equivalent to mean annual falls in the level of the lake of 19·3, 25·9, 25·7 centimetres. The annual residue of the actual fall, 1·8, 14·3, 18·0 centimetres, will in all probability be accounted for by evaporation and by deficiencies in the contributions of other tributary rivers.

THE SHIFTING OF THE CLIMATIC BELTS.—Professor A. Penck, of Berlin, lectured to the Royal Scottish Geographical Society in March on the shifting of the climatic belts. Corries, similar to those at present found in countries where the land rises above the snow-line, exist at a much lower level, not only in such lands, but also in others, within and without the tropics, where there is not now perennial snow. These must have been excavated by the action of corrie glaciers, and they may be taken to indicate the former glaciation of the areas in which they are found. The ancient snow-line, as delineated by them, followed the present line where perennial snow exists with remarkable persistence and at a uniform interval of four thousand feet below it. In many regions, now arid deserts, the surfaces of the lakes are shown by ancient terraces to have stood once much higher than at present, and in such regions, also, river courses, the excavation of which cannot be assigned to spasmodic floods, are now dry. As Professor Penck reads this evidence, the Glacial epoch coincided with a time when the equatorial belt of arid deserts was much narrower than at present.

GEOGRAPHY.—Mr. B. J. S. Cahill, of San Francisco, sends a reprint of a paper describing a "new and original" projection for a land map of the world, which appeared under his name in the *Journal of the Association of Engineering Societies* (U.S.A.), October, 1913 The hemispheres are projected each in four equal quadrants, beginning at the meridian of 22½° W. The projection is conical with two (unspecified) standard parallels, but the meridians are curved inwards for about one-fifth of their length to the Pole and Equator, the Equator being straightened in each quadrant over about its middle three-fifths. The quadrants of the northern hemisphere are arranged in series with the straight parts of their bounding meridians in contact, the corresponding quadrant of the southern being connected to each by the straight part of the Equator. No method is given for the construction of the projection, and no discussion of distortion. The "mechanical demonstration," to show that an almost perfect representation of the sphere is obtained on the plane, is, of course, unsound, and the idea of a large wall map of the world folding into "regional" sections is not of any use. The author obviously does not appreciate the needs of the geographer, nor the amount of novelty or value in his production. The fact that distortion is confined mainly to the oceans does not do away with distortion, nor with its effects in rendering the map unsuited for many purposes. Mr. Cahill has received commendation from many geographers of standing, and that is a guarantee that his map, which on a small scale gives very useful ideas of the world as a whole, will suit one or two of the many purposes for which he believes it ideal.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

MAN AND THE RATE OF EROSION.—An interesting letter, from Mr. J. Gurney Barclay, appears in "Knowledge" for March (pages 107–8), dealing with a phase of the above subject raised in one of my January Notes ("Knowledge," January, page 31), which was based on a paper by Mr. H. S. Shelton on "Some Aspects of Geological Time." It is therein argued that the rates of erosion calculated from rivers whose basins are extensively cultivated are abnormally large, because cultivation exposes the soil to denudation, and thus raises the rate of erosion. It is suggested that the normal rate of erosion, upon which datum calculations of the age of the Earth are made, should be obtained from rivers whose basins have been unaffected, or little affected, by the agency of man in cultivation. Mr. Barclay, however, puts forward the converse proposition, namely, that man has settled in those areas where the rate of erosion is greatest. "A high rate of erosion is usually coincident with a heavy rainfall, and these two facts together tend to make the wide, fertile plains which, naturally, are the chief habitat of man on this Earth." But these wide, fertile plains are the results of deposition, not of erosion. If man settles in areas where the rate of erosion is greatest, why are not the great centres of population in the mountain regions instead of in the plains? The rate of erosion varies in the different parts of a river. It is probably greatest in its early middle course, where it debouches from the mountains. Hence its volume is much greater than in the mountains, and its gradient is still comparatively steep. In the plains, however, erosion is almost balanced by deposition. During the formation of the great alluvial plains deposition must actually exceed erosion in the lower reaches of the river. The whole point is that man, by the cultivation of the land, by stripping the protective covering of herbage and trees, tends to disturb this nice balance between erosion and deposition, and to tilt the balance in favour of erosion.

ABNORMAL STREAM TRANSPORT IN PERTHSHIRE AND ARGYLLSHIRE.—Mr. J. Gurney Barclay, in the above-cited letter, also states that British geologists are apt to base their estimates of erosion on what they see in the British Islands, disregarding the far grander manifestations of the erosive power of rivers and other agents in more mountainous countries. This is to some extent true, and illustrates the corrective habit of travel, in geological as well as in other fields of human activity. In the Scottish mountain districts, however, we have occasional manifestations of erosive power that recall, if they do not rival, those cited by Mr. Barclay in Japan. For example, the storm of August 5th, 1912, in the Cowal district of Argyllshire (W. R. Smellie, *Transactions of the Geological Society of Glasgow*, Vol. XV, Part 1, 1914), wrought an amount of damage that required £10,000 of the Cowal ratepayers' money to make it good. On the above date a great thunderstorm broke over the district after several

days of heavy rain. Whilst the collecting areas of the streams in this district are quite small in relation to rivers in general, their peculiar shapes made inevitable an enormous transport of material. The following is Mr. Smellie's statement of the peculiar conditions: " . . . (a) A comparatively large drainage area with the numerous headwaters situated at approximately equal distances from the mouth of the main stream; (b) side-streams with steep gradients, about 1 in 2·6 . . . main streams with gradients which could be as low as 1 in 6; (c) streams debouching suddenly on to an almost flat alluvial plain. Given these conditions in any part of the affected area, and a disastrous transport of huge boulders (ranging up to six feet in diameter) was inevitable. The large gathering-ground accounted for the large volume of water, the arrangement of the tributary streams ensured the simultaneous arrival of their contributions, and the gradients implied a very high velocity." Tremendous masses of great boulders and trees were piled on to the alluvial flats, and spread over the adjacent road. At Barnacabben "the stream forked as soon as it met the alluvial plain, and just in the fork, and facing the gully, a small house was situated. As in the former case, the boulders, unable to divide with the stream channels, drove straight on and through the house, wrecking it utterly, and leaving only two battered end-on gables rising from a heap of boulders." Mr. Smellie concludes that streams, during a few hours' exceptional activity, can accomplish more work than they could in several decades at their ordinary rate.

Almost identical phenomena were witnessed in Upper Strathearn, Perthshire, during and after a great three hours' storm on Wednesday, August 24th, 1910. An excerpt from Mr. P. Macnair's paper, describing the effects of this storm will show the character and rate of the erosion (*Transactions of the Glasgow Geological Society*, Vol. XIV, Part II, 1911). "According to eye-witnesses, the ground seemed to tremble as if affected by an earthquake, and every now and then huge boulders came into collision with each other, making a noise like the sound of distant artillery. Near the bridges over the road and railway, the stream having been constricted, piles of boulders and sand were accumulated. At these obstructions the water rose high in the air, tossing about huge tree-trunks and boulders as if they were pieces of straw." Some of the boulders carried down were estimated to weigh three tons, whilst many hundreds weighed from one to two tons.

METEOROLOGY.

By William Marriott, F.R.Met.Soc.

IS THE EARTH DRYING UP?—Professor J. W. Gregory, F.R.S., discussed this question at a recent meeting of the Royal Geographical Society. Owing to the varied nature of the evidence to be considered, the extensive and scattered literature whence much of that evidence has to be gleaned, and the contradictory opinions expressed by high authorities, the problem whether the Earth is drying up is hedged about with difficulties. But one fact seems to result clearly from the evidence: there have been many widespread climatic changes in late geologic times, while in historic times there has been no world-wide change of climate. If particular countries are considered, such as Egypt and Palestine, the balance of expert opinion is strongly in favour of the view that there has been no climatic change in either since the earliest existing records. The belief in a lesser rainfall in Palestine has been fostered by the oft-repeated comparison of the Hebrews between the stony wilderness of Sinai and the matured fertility of Canaan. But it may be concluded, from the most precise tests now available, from the range of the date palm and the vine, and from the facts recorded by Old Testament writers, that the climate of Palestine is the same to-day as in the time of Moses.

Returning to the wider question, geological evidence shows how the passage from the climate of the Glacial period to that of our own day has been a gradual rise in temperature since the disappearance of the ice, accompanied either by an increase or decrease in humidity. In other countries the glacial conditions were succeeded by a warm, dry period, followed again by wetter conditions. This increased humidity characterises the present climates of Scandinavia, Germany, Hungary, Roumania, the eastern and southern parts of North America, parts of Africa from Nigeria to Cape Colony, and there is some evidence of the same change, following a dry post-Glacial period, in England.

As an increased rainfall has been demonstrated for so many parts of the world, it is only natural to expect a compensating decrease in other districts; and there is, accordingly, a predisposition to accept the claim that Central Asia is suffering from increasing desiccation. Yet it is well to remember that the extent of such change may be easily exaggerated by attributing to recent climatic changes the effects of prehistoric variations. For archaeological and historical evidence shows that Central Asia, and even the coasts of Persia and Baluchistan, had a very arid climate in the earliest times of which we have human records; that the Caspian Sea was at least as small and as low in the fifth century as it is now; and that the African and Asiatic deserts are in places again passing under cultivation, though it must be admitted that, while there is a strong balance of opinion in favour of the view that the aridity in Asia is being still increased, there are weighty authorities on the other side.

Professor Gregory says that the explanation of the conflicting views may be that in Central Asia the desert is widening in some places and contracting elsewhere. That the total rainfall in Central Asia has diminished is, however, probable, as an accompaniment to its increase in parts of Europe. Variations in the distributions of rainfall must result from any considerable alteration in the level of the land; the uplift of a continent must cause the rainfall to become heavier on the margins and lighter in the interior. The increase of rain on the coast lands would, however, hasten their lowering by denudation, and, again, the rain would sweep over the interior; hence that marvellous geographical equilibrium which has rendered possible the unbroken course of evolution would in time, unless checked by renewed uplifts of the coast lands, restore the more even distribution of rain, and revive the desolate regions in the heart of a continent.

REMARKABLE UPPER-AIR RECORDS AT BATAVIA.—Dr. W. van Bemmelen, in a recent letter to *Nature*, stated that two sounding balloons, which were liberated at Batavia during the past rainy season, met with exceedingly low temperatures when entering the stratosphere at the usual height of about 17 kilometres (10·6 miles). On December 4th, 1913, $-90^{\circ}\cdot9$ C. ($-131^{\circ}\cdot6$ F.) was registered, and on November 5th, $-91^{\circ}\cdot9$ C. ($-133^{\circ}\cdot4$ F.). Though in the latter case the clockwork had stopped, Dr. van Bemmelen says the register may be accepted without reservation. This air temperature of $-91^{\circ}\cdot9$ C. is the lowest on record.

On December 4th the balloon reached a height of 26,040 metres (16·2 miles). What is most remarkable in the temperature record is that from 17 kilometres upward an increase from $-91^{\circ}\cdot9$ C. to $-57^{\circ}\cdot1$ C. is shown, the latter agreeing with the value that is usually found in Europe. In former balloon ascents made in Batavia, temperature records have been obtained only twice for heights above 20 kilometres. In one of those cases (August 6th, 1913) an increase similar to that of December 4th was recorded, viz., $-82^{\circ}\cdot6$ C. at 17 kilometres, and $-63^{\circ}\cdot7$ at 22 kilometres; in the other case, however (October 2nd, 1912), the temperature showed a much smaller increase (-80° C. to -75° C.), the balloon reaching 23 kilometres.

CLIMATE AS TESTED BY FOSSIL PLANTS.—At the meeting of the Royal Meteorological Society on March 18th Professor A. C. Seward, F.R.S., gave a lecture on "Climate as Tested by Fossil Plants." Problems connected with the climates of past ages have long exercised the minds of scientific writers, both from an astronomical standpoint and from the point of view of the gradual development and wanderings of plants and animals since the earliest periods that have left recognisable records. An estimate of the value of plants as "thermometers of the ages" necessitates an enquiry into the power of acclimatisation of recent plants and their ability to respond to external stimuli: a comparison of land and water plants illustrates the plasticity of vegetative organs, and the intimate relation between form, structure, and environment; similarly, plants growing in dry places, or under other conditions unfavourable for the absorption of water, are characterised by certain structural features reflecting the circumstances in which they live. A comparison of individuals of the same species grown at high altitudes, at lower levels, or before continuous light, afford striking evidence of the power of adaptation. The difficulty of using fossil plants as tests of climate becomes increasingly great in proportion to the degree of difference between the extinct types and their nearest living relations. It is from the examination of petrified plants, the delicate tissues of which are almost perfectly preserved, that data may be obtained throwing light on climatic conditions. This method of enquiry is best illustrated by a consideration of some of the anatomical features of the leaves, stems, and roots of trees which grew in the forests of the coal period; the form and arrangement of cells in the leaves indicate fairly bright sunlight; large spaces in the cortex of roots point to growth in swamps. The geographical distribution of plants during the latter part of the Palaeozoic era affords evidence of the existence of two botanical provinces, a northern province characterised be a luxuriant flora living under conditions more genial than those to which the poorer flora of the southern hemisphere was exposed. The presence or absence of rings of growth in the petrified stems of plants may afford evidence of the occurrence or absence of seasonal changes. A general survey of the Jurassic flora of the world leads to the conclusion that the climate was comparatively uniform, and in Arctic and Antarctic regions much more genial than at the present day. The fossil floras of more recent geological periods furnish clear evidence of subtropical conditions in Europe; in later times the occurrence of northern types in Britain heralds the approach of the Glacial period, and in post-Glacial beds are found fragmentary remains of immigrants from neighbouring floras which have largely contributed to our present flora.

MICROSCOPY.

By F.R.M.S.

NICTERIBIA.—In many cabinets of microscopic objects there will be found mounted specimens of what are variously labelled "Parasite of Indian Bat," or "Parasite of Flying Fox," the structure of which is so peculiar that those who have not yet examined it are strongly recommended to do so. The bat itself is one of the Megachiroptera, or fruit-eating variety, and is found only in warm climates. Like most other creatures, it is afflicted with ecto-parasites, the chief of which is the *Nicteribia* under consideration. The body of this parasite measures from ·175 inch to ·235 inch in length in the male, and is about ·25 inch in the female, but the legs are about ·3 inch in both. The head, furnished with maxillary and labial palpi, is, when at rest, folded back, and rests in a depression on the dorsal surface of the thorax. The eyes are simple, and five in number on each side, ranged round an elevation similar to that of the vertex in the flies. The rostrum, apparently, consists of two parts, serrated at the ends, and forming a tube when placed together. The rapid and peculiar motion of a bat when flying would seem to render special provision necessary to enable its parasite to hold on; hence we find a curious comb-like structure on each side of the ventral portion of the thorax, between the first and second pair of legs, and a similar comb along the edge of the first abdominal segment, the former consisting of about fifteen spines, and the latter of about forty, these being admirably calculated to catch in and hold on to the remarkable imbricated hairs of the bat. The body and legs of *Nicteribia* are covered with smooth, tapering hairs, of various lengths, which form a fringe round the extremity of the abdomen in the female. The spiracles are six in number on each side, but do not present any unusual features. The legs are long in proportion to the size of the insect, the tarsus consisting of five joints, of which the first is long, slender, and flexible, and the four which follow—the last one bearing the claws—are short. The claws themselves are sharp and much recurved, and two small pulvilli extend from the base of the claws. The particular specimens described are believed to be *N. hopeii*, but other species are known, and occasionally mounted as microscopic objects.

The Nicteribiidae, though wingless, are placed by entomologists in the order Diptera. R. T. L.

THE RADULA OF *HELIX RUPESTRIS* (DRAP.).—Six years ago I stated (*Proc. Malac. Soc.*, VIII, 126) that the radula of *H. rupestris* was like that of *lapicida*, and quite unlike that of *rotundata*. Some doubt having been thrown upon this statement, I have now reëxamined the species, using fresh material. I find that the resemblances and want of resemblance are still as they were: *lapicida* and *rupestris* have broadly conical central and admedian mesocones, the ectocones being more or less completely hidden. *Rotundata*, on the other hand, has very prominent ectocones throughout, so that the appearance of the middle of the radula is equally distinct and characteristic. The external basal plates in the two former species are oblong, and three or four times as long as they are broad. In *rotundata* the oblong is irregular, and the relation of length to breadth is more like two to one. The cones of the external unci form regular pectinations in *rupestris*, and occur in equal groups of three or four in *lapicida*; while in *rotundata* they are uneven, and of the Arionid type. The regularly pectinate form is found in young *lapicida*, as in *rupestris*. In *rotundata* embryos the form is serrate, not pectinate. The embryo *rupestris* (as found inside the parent shell) has three admedians: these with the central show ectoconic differentiation, as all young Helicids do, but the central mesocone is already stout and ovate. At no stage do we get the lancet-shaped cones so characteristic of *rotundata*. The *rupestris* embryo has five pectinate externals: its basal plates are square and oblong, like those of the adult. An adult specimen has 172 rows of 37 (11, 7, 1, 7, 11) unci. Another has 181 rows. Thus the total number of unci will be six or seven thousand. There is no great difficulty in extracting the radula of *rupestris*; indeed, it comes to daylight more easily than that of *pomatia*. In order to see the details of the cones, it is at least advisable to use an objective of N.A. 0·9, and apochromatism is here more than an advantage—almost a necessity. With bad definition in the objective or faulty adjustment of the condenser it is easy to be misled by false images of the lacinial margins. By injudicious use of the iris diaphragm it is possible even to see such things as are depicted in the usual drawing of *Punctum pygmaeum* (radula). But I am forgetting—surely no reader of the Microscopy column of "KNOWLEDGE" requires these elementary hints. E. W. B.

PHOTOMICROSCOPY.—The Photomicrographic Society, which is just at the close of its third year of existence, continues to do much good work. The general trend is that each worker should restrict his general work to some fairly

well-defined line. This development towards specialisation has the support and encouragement of all the leading workers. The President for the time being, Dr. Rodman, rightly supports this policy, both by precept and example. His presidential address took the form of a lecture on the study of pollen grains, which extended to some thirty or more orders of British plants. These objects lend themselves particularly well to reflected (top) light on a dark ground. It would appear that, as a rule, plants belonging to the same natural orders display a strong family resemblance in the form of their pollen grains, though here and there one meets with very marked departures from the type of the order. The size of the pollen grains bears no immediate relationship to the size of the plant. Naturally, the pollen of anemophilous plants is smaller in size, and so better adapted for wind-carriage, while the larger size of the entomophilous plants is not so likely to be missed by visiting insects. Some simple and quick method of mounting pollen without pressure would be an acceptable addition to our craft. Some little time ago Mr. Noel Heaton discoursed on the microscopic examination and photography of some gem stones; whence it was gleaned that one of the ways of distinguishing between natural and synthetic rubies was by regarding the form and arrangement of certain tiny bubbles, which in the one case were more or less spherical, and in the other elongated to ellipsoid form. Indeed, in some cases one saw a moniliform arrangement, reminding one of the droplets on the thread of a spider's web. But in the two cases the causes were hardly comparable at all.

Owing to the kindness of the firm of Messrs Leitz, whose English branch is in the capable hands of Mr. J. W. Ogilvy, the Photomicrographic Society was able to hold one of its evening meetings at the Leitz establishment in Bloomsbury Square. On this interesting occasion somewhat of a record in photomicro-projection was made. A large and characteristic series of rock-sections had been cut, mounted, and photographed by Mr. C. H. Caffyn. These photomicrographs were taken with polarised light on colour-screen plates. When such microcolour-pictures are projected on the screen, everyone asks, "Are those the exact colours you saw through the microscope?" There is only one satisfactory answer to such a question, *i.e.*, by showing the original and the photographic reproduction side by side, so that all their corresponding parts may be leisurely compared. On this occasion a specially designed projection microscope was used, and matters so contrived that on a large screen there was projected the photomicrograph in colour, and alongside it a projection image, through the polarising microscope. To make matters more complete these two pictures agreed precisely in size and subject, *i.e.*, two versions of the same thing. The closeness of the resemblance in the big majority of cases was quite startling, and says a very great deal for the joint authors of the display, viz., Messrs C. H. Caffyn and J. W. Ogilvy.

INTELLIGENCE IN PARASITIC ROTIFERS.—(1) Acts of intelligence in Rotifera seem to be most clearly shown in parasitic species, and on observing their behaviour under the microscope one cannot help coming to the conclusion that these acts are controlled by the tiny speck of clear, transparent brain, which one can look through and into at the same time.

The most common of parasitic Rotifers are the two small species inhabiting the green moving spheres of *Volvox globator*: *Proales parasita* Ehrenbg. and *Hertwigia volvocicola* Plate. Both can live and swim about freely in the open water, but they usually find it more convenient to ride luxuriously inside the roomy saloon of a Volvox, which at the same time provides them with a larder, for they feed on the young buds and green gonads of the plant (or animal), and then lay their eggs and raise a family, all in the same protected and private apartment, and whilst sailing about the world. It is curious to watch how one of these Rotifers first manages to gain an entrance into the green sphere. The little Proales fixes itself to the surface, and by means of its pincer-shaped jaws bites a small hole through the thin skin of the Volvox, very much too small to allow of the passage of its body, and particularly of the stomach, which usually is the stoutest part of it; then the head is pushed through, with much wriggling, pushing, and exertion: the work is continued till half the body is through. At this stage the animal looks like a dumb-bell, half inside and half outside the wall of the Volvox, with the thick stomach and its contents outside, looking as if there were very little chance to succeed in its task. Just then a very clever trick is performed by the little Rotifer, one of those acts which are done, not mechanically, but appear to be thought out with due appreciation of its effects and results. It stops wriggling, but pushes the contents of its stomach back, then passes the empty forepart of the stomach through the constricted part of its body, followed by the contents, particle by particle, like sand-grains pass through the narrow part of an hour-glass, and one can watch the stomach gradually growing and filling on the other side of the wall. After the contents of the stomach and intestine have thus passed over, the remainder of the body glides through readily, and the little Proales is inside the Volvox, ready to explore its new habitation. One would think that it would have cost little extra labour to bite a somewhat larger door in the wall of the Volvox, in order to obtain an easy entrance; but no, the smallest, almost imperceptible, hole is made, apparently to ensure privacy and prevent enemies and competitors from gaining an entrance into its domain. I have not yet observed a fight in defence of this small open door, but one can readily imagine how helpless an intending intruder would be when held firmly half inside and half outside of the wall, and what an easy task the person in possession would have to defend his house and home, though it be a freebooter's. It is true that several specimens are often found in the same Volvox sphere, but these are sisters, born there from eggs laid by the parent.

Ehrenberg's popular name for *Proales* (*Notommata*) *parasita* was "the pirate" (*der Raubschiffer*), because it was sailing in a captured craft. It may be mentioned also that this species is not Gosse's *Proales parasita*. The latter is a small barrel-shaped Rotifer without a foot, resembling members of the genus *Sacculus* (*Ascomorpha*), which was later described by Plate under the name of *Hertwigia volvocicola*. Both species are often met with in different gatherings of *Volvox globator*.

C. F. Rousselet.

(*To be continued.*)

THE QUEKETT MICROSCOPICAL CLUB.—At the meeting of the Quekett Microscopical Club, held on March 24th, 1914, Mr. N. E. Brown, A.L.S., read a paper on "Some Notes on the Structure of Diatoms." The chief part of this paper was an account of the observation of very minute pores, having a diameter of the order of $0\cdot1\mu$, in a *Pinnularia*, *Pleurosigma balticum*, *P. angulatum*, *Surirella gemma*, *Nitzschia scalaris*, and several other forms. A one-twelfth oil-immersion of N.A. 1·3, and eyepieces to bring the magnification up to at least one thousand diameters, and often not less than two thousand diameters, combined with very careful manipulation, a most exact arrangement of the light, and a fair stock of patience, are required to make the structure clear. The author was led to search for these pores by observing, on several occasions, behaviour of diatoms which could be most reasonably explained by assuming the presence of exceedingly fine pseudopodia, having a length of about 1/3000 inch. Mr. E. M. Nelson, F.R.M.S., described the new Zeiss one-seventh oil-immersion short-tube objective. This has N.A. 0·9. The corrections are very perfect. Although no fluorite is used in its construction, it shows a considerable advance over semi-apochromatism, and exhibits only a slight trace of outstanding blue. It will just show the striae on *Grammatophora oceanica* (88,000 to the inch). The capabilities of the new objective were exhibited by Messrs. Zeiss on four stands. Mr. E. M. Nelson, F.R.M.S., also discussed "A

New Way of Using an Object-glass for Diatom or other Resolution." It is as follows:—

1. Place the diatom so that its striae to be resolved are vertical in the field.

2. Set up a critical image with the edge of the flame in focus and central to the field, and open the iris to its fullest extent.

3. By means of the substage centring screws move the condenser so that the image of the flame lies just outside the field of a high-power eyepiece. If the striae are within the limits of the objective they will be at once resolved without any trouble with stops, slots, or other apparatus.

The President, on behalf of the Club, offered to Mr. T. H. Powell, F.R.M.S., one of its oldest members, hearty congratulations on the attainment of his eightieth birthday. Mr. Powell joined the club in 1865. In spite of his great age, he is still able to take an active part in microscopy; and at the conversazione of the club, in February, exhibited an object, under a high-power objective, constructed by himself. Mr. Powell acknowledged in suitable terms the very hearty reception of the President's remarks by the members.

On April 4th the first Saturday afternoon excursion of the season took place, the Botanic Gardens, Regent's Park, being visited. The attendance was good, although the weather was somewhat unpropitious. Specimens in the various fields of research were obtained from the large lake. *Eudorina elegans* was extremely abundant, examples showing the division of the contained individual cells into juvenile colonies, preparatory to multiplication, were numerous. The minute flagellate organism, *Dinobryon sertularia*, was plentiful in the same gatherings. The remarkable resemblance in general outline to the marine *Sertularia* gives it an interest, while, from its small size, movement, and transparent delicacy, it forms an object by no means easy to observe satisfactorily.

At the "Gossip Meeting," held on April 14th, notwithstanding its proximity to the Easter holidays, there was a good display of microscopes and objects by members. *Callidina papillosa*, *Conochilus volvox*, *Mniobia tetraodon*, *Habrotrocha constricta*, *Callidina vorax*, and *Adineta sp.*, among the Rotifera, were shown, as was also *Bursaria vorticella*. A Caddis tube formed of sand, opened out and exhibited under polarised light, was attractive, while a section of leaf of Meadowsweet, showing a gall formed by *Cecidomyia ulmariae* was under one instrument. A large number of insects of very various kinds, ants, flies, beetles, wasps, etc., preserved in eucalyptus oil, had been forwarded by a correspondent in South Burma for distribution among the members, who gladly availed themselves of the opportunity of acquiring such examples of exotic life. A quantity of "pond life," both animal and plant, in preservative fluid, from the same source, was also provided, and taken advantage of.

PHOTOGRAPHY.

By EDGAR SENIOR.

TRANSPARENCIES ON COLLODION EMULSION.—It has long been recognised that for certain purposes, such as in the production of cloud negatives, collodion is superior to gelatine, and as collodion emulsion can now be rendered isochromatic, and at the same time an increase of sensitiveness imparted which approaches to that of a modern gelatine plate, the difficulties of prolonged exposure no longer present themselves. Then, again, a desirable quality in a cloud negative is, that it should be possible to print from either side of it, and for this reason a film negative is preferable to one on glass; and as collodion lends itself particularly to stripping, either by means of a solution of gelatine poured on and allowed to become dry, or by the use of the lotus films already described in a former article, this is a special recommendation in favour of the use of collodion. But it is in transparencies, either for the lantern or other purposes, that collodion emulsion holds its own, in spite of the many brands of gelatine plates specially prepared for this class of work. The preparation of washed emulsions has now been reduced to such simplicity as to be readily accomplished by anyone taking ordinary care. For transparencies there is no necessity for great rapidity in the emulsion. The chief secret appears to lie in using a suitable pyroxyline in making the collodion. There is no necessity, however to make the emulsion "except for those who are interested in doing so experimentally," as excellent emulsion is to be purchased ready for use, such as that supplied by Messrs. A. W. Penrose & Company, of 109, Farringdon Road, London, which the writer has employed with the greatest success on many occasions. There is a great advantage in the use of collodion emulsion, as so much can be done with the image after it is fixed. As an example, a very thin image can be readily intensified until a satisfactory result is obtained, and this operation can be carried out in daylight, without any risk of staining the film, which will still remain clear glass in the high lights. Then, again, any trace of fog, due to over-exposure or development, can be very readily removed. However, if much after-treatment is required it will be found necessary to resort to some means for preventing the film leaving the glass during the manipulations. For this purpose a substratum is frequently recommended, although it is not advisable to employ one, as it is the frequent cause of spots, stains, etc., and a good edging of india-rubber dissolved in benzol is all that is required, and answers perfectly. The india-rubber solution employed by the writer is made as follows:—

India-rubber (pure)	6 grains
Benzole (pure)	1 ounce

This is applied for about one-eighth of an inch all round the plate "which has been previously made chemically clean," and when dry the plate is ready for coating with the emulsion, which must be done to the very edges, as well as the extreme corners, since if any place is missed the water used in washing will get under the film and cause trouble, while if the edging and coating be properly carried out almost any force of water may be applied without risk of damage. It is advisable, however, to always keep the plate in an horizontal position. The colour of the image will depend chiefly upon the exposure, although it is modified to an extent by the developer employed; but where warm tones are required a full exposure must be given, as a short exposure results in cold tones. For fixing, potassium cyanide has certain advantages over hypo, but whichever is used the following formulae should be employed:—

CYANIDE FIXING SOLUTION.

Potassium cyanide	20 grains
Water	1 ounce

SODIUM THIOSULPHATE (HYPO) FIXING SOLUTION.

Sodium thiosulphate	4 ounces
Water	20 ounces

After the image has been fixed and well washed, if there is any trace of fog it may be easily removed by means of a solution of iodine, followed by potassium cyanide, or the two may be used together. For use in this operation the following solution is made up:—

IODINE SOLUTION.

Potassium iodide	20 grains
Iodine	5 ,,
Water	1 ounce

A few drops of this are added to one ounce of water, when some of the cyanide fixing solution is added, drop by drop, until the sherry colour, due to the iodine, is completely discharged. The solution is then poured over the film and returned to the measure, the operation being repeated until the fog has disappeared, when the plate must be well and quickly washed. The operation of clearing can be done in daylight, and is a method well known to wet collodion

workers. After this treatment the image may appear too thin, and require intensification. For this purpose the following redeveloper should be employed :—

Pyrogallol ...	... ...	2 grains
Citric acid ...	... ...	3 ,,
Water ...	... ...	1 ounce

About half an ounce of this solution is taken, and a few drops of silver nitrate added, of a strength of about ten grains to the ounce of distilled water. This is poured on and off the film until the required intensity is obtained, when the plate is well washed. Should the image obtained be too warm in colour it may be modified by placing it in a solution of platinum bichloride of the following strength :—

Platinum bichloride	... ...	1 gram
Water ...	... ...	10 ounces

In this it will gradually change from red to purple, and, finally, black. The action, however, must be stopped short of the colour required when finished, as the image dries blacker. It must not be thought that, starting with a black image, the toning solution will give a warm tone, as warm tones, by development, are only obtainable by giving sufficient exposure, when, if too warm, the platinum solution will modify it. If by any chance the toning is carried too far, the image, after well washing, should have the cyanide fixing solution poured over it, when it will change to very nearly the same colour as at first, and may then be retoned to the desired depth. A properly prepared emulsion should give absolutely clear glass in the lights of the picture ; but with some samples of pyroxyline a slight milky or opalescent appearance is imparted to the film. This, however, will disappear on varnishing, but except in such cases it is better not to varnish, as it is very difficult to avoid specks of dust which show when the image is projected upon the screen. We have before us as we write a number of lantern slides made on collodion emulsion and developed with glycin, in which a solution made up according to the following formula was employed :—

Glycin	... ...	6 grains
Potassium carbonate	... ...	25 ,,
Potassium bromide	... ...	1 grain
Water	... ...	1 ounce

This developer gives a pleasant warm black colour itself, and beautiful gradation in the image, and the colour may be further modified by treatment, to different extents with Mr. W. B. Ferguson's copper ferrocyanide toning solution. The alkali used in the developer also affects the tone of the picture, carbonate of ammonia tending towards a red, while carbonate of soda imparts a greenish hue. But the chief factor in determining the colour is the exposure given to the plate.

PHYSICS.

THE APPLICATION OF POLARISED LIGHT TO ENGINEERING PROBLEMS OF STRESS AND STRAIN. —The action of glass in a condition of strain upon polarised light has long been known, although the phenomenon was regarded mainly as bearing on the conditions of stress existing within more regular crystalline structures. Professor E. G. Coker has for some time been investigating the subject from an engineering standpoint, and has from time to time brought the results of his researches before the scientific world, both at the Royal Society and the Royal Institution. The writer has recently had the advantage of hearing and seeing some of Professor Coker's latest results. Light from a powerful lantern was polarised by reflection, and the screen was made dark by a Nicol prism "crossed," *i.e.*, with its plane of polarisation at right angles. A xylonite model of a girder was then placed between the polariser and the analyser, and subjected to stress. Immediately the field became coloured, a dark line down the middle of the bar showing the region of neutrality. By the colour of the light at any particular point the stress at that point can be determined as accurately as by mathematical calculation. The colour depends on the stress, and is the same whether that stress be a tension or a pressure. The variations of stress in plates, and particularly the great increase of stress in the neighbourhood of sharp corners, *e.g.*, the corners of square holes in the model of the deck of a ship, were strikingly shown on the screen. Models of spiral springs, trains of wheels, and other contrivances served to illustrate the manner in which a phenomenon of what might have been thought to be of purely physical interest has been made to furnish results of importance to engineers

W. D. Eggar.

LECTURE ILLUSTRATION OF A MOVING CONDUCTOR IN A MAGNETIC FIELD.—When a carbon filament lamp is placed in the field of an electro-magnet, the one (preferably the lamp) being supplied with alternating current, and the other with direct current, the filament is set into violent vibration. This effect affords an illustration of a well-known phenomenon, and will probably interest readers of "Knowledge."

The carbon filament which I found to show the effect best was one with a fairly free helix, supported in the centre. The vibration was more violent when the axis of the helix was at right angles to the magnetic field than when it was parallel to it. If the magnetic field is sufficiently strong, the coils strike together, and in some cases present the appearance of having a curious spinning motion. If an alternating magnet and an alternating current filament of the same period be used, the effect is much smaller.

With a direct-current magnet and direct-current lamp a single motion of the filament is produced, but for this to be appreciable a rather strong field is required.

In order to utilise this effect for a lecture experiment, it is only necessary to project the image of the filament on a screen by means of a lens, the axis of the helix being parallel to the screen, and to bring the electro-magnet up behind the filament, and perpendicular to the helix, when the image of the filament on the screen broadens out ; a stroboscopic disc running slightly out of tune with the filament would render the motion on the screen slow, and easily followed. Since the magnetic field required is quite small, this effect with the alternating lamp or magnet provides a convenient illustration of the motion of a conductor conveying a current in a magnetic field.

J. H. T Roberts.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A., LL.D.

EYES THAT SHINE AT NIGHT.—Everyone knows the gleam of a cat's eyes when a light catches them in the darkness. This appears to be due to reflection from a layer behind the retina called the choroid tapetum. This layer includes numerous flat cells packed with crystalloid bodies which act like a mirror. In some beetles and moths the eyes shine like rubies when they are obliquely illumined at night. Professor Bugnion has recently studied the eyes of one of the hawk-moths (*Sphinx euphorbiae*), and finds that the retina is very thick and infiltrated with a rose-coloured pigment, "erythropsin." Part of the retina forms a tapetum, and the reflection is due to a network of silvery air-tubes, or tracheae, helped to some extent by movement of the retinal pigment. It is probable that the reflection of the light rays from the tapetum is advantageous, since the visual cells are thus affected twice instead of once.

THE FLIGHT OF THE HOUSE-FLY.—Dr. Hindle finds that house-flies tend to travel either against or across the wind. This direction may be directly determined by the action of the wind, or indirectly, owing to the flies being attracted by odours borne by the wind. Fine weather and

warmth favour dispersal, and flies travel further in the open country than in towns—probably because the houses offer food and shelter. In thickly housed localities the usual maximum flight is about a quarter of a mile, but in one case a single fly was recovered at a distance of seven hundred and seventy yards (partly over open fenland). When set free in the afternoon flies do not scatter so well as in the morning. Liberated flies often mount almost vertically to a height of forty-five feet or more.

MATERNAL CARE IN EARWIGS.—H. H. Brindley notes that the eggs of earwigs are usually found in a little pit in the soil about an inch below the surface, or else in convenient crevices in vegetation. The mother watches over them, but there seems to be no foundation in the assertion that she guards the young. Before hatching she covers the little pile of eggs with her body or else plays over them with her antennae. After the young are hatched, and freed from the egg-membrane, which is sometimes difficult, the mother displays no interest in them. The newly hatched earwigs are active, and begin to feed in a few hours, possibly less. It may be noted that several authors of good repute have offered some confirmation of De Geer's statement that the mother earwig shelters the young.

TENACITY OF LIFE.—Various fungoid organisms have been known to survive twenty-two years' desiccation; various Bacteria have remained alive without air, but with moisture, for ten to twenty years; sediments, containing various Protozoa, have shown revivification after five to six years. F. Noc relates that some tubes, with a little water and various Protozoa, were hermetically sealed in 1908, and were recently examined. There was no trace of the Infusorians which were there to start with, but there were encysted Amoebae some of which revived after ten days or so. Some Protozoa, dried on Tonkin commercial paper, were revived after five years. One of these was a small Flagellate (*Oikomonas termo*).

PECULIAR AIR-SAC IN A LEMUR.—In a species of *Microcebus* from Madagascar R. Anthony and I. Bortnowsky describe an extraordinary peculiarity—a large sub-cutaneous air-sac lined with stratified epithelium, extending all over the animal's back and out to the bases of the limbs. It seems to be in communication with the air-passages, probably with the windpipe behind the larynx; but this point remains for the time being undecided. There can be little doubt that the air-sac is in some way connected with the Lemur's arboreal life, and the investigators suggest that it has to do with balancing or equilibration.

ANTARCTIC NEMATODES.—In reporting on the free-living marine Nematodes collected at Cape Royds on the Shackleton Expedition Mr. N. A. Cobb calls attention to their abundance. Hundreds of them, males, females, and young, were taken from a mere thimbleful of the dredgings. Twenty-five new species are described, mostly vegetarian. They seem to be rather smaller than species in warmer seas, but they do not seem to be less prolific. "It is hardly conceivable that the body temperature of the marine polar species is higher than that of the water in which they live, namely, near the freezing-point of fresh water; and yet, in spite of the freezing temperature and the long polar night, Nematode protoplasm seems to glide on through its mitosis dance to much the same purpose as if bathed in equatorial light and esconced in the warm pools of tropical reefs."

YOUNG SAND-EELS IN THE NORTH SEA.—Dr. Alexander Bowman has shown that, with the exception of a relatively small number of specimens found in the neighbourhood of the Firth of Forth, no larval sand-eels occur in the plankton in the northern portion of the North Sea in the first two months of the year. They suddenly appear in countless numbers in the month of March. On one occasion as many as nineteen thousand eight hundred and sixty individuals (of *Ammodytes tobianus*) were captured near the bottom (where they are hatched) in a single horizontal haul of half an hour's duration. The spawning grounds are in great part determined by the depth and the character of the bottom; the eggs are not laid in very shallow or very deep water, or on a very muddy bottom. The frequency is low inshore and in the deeper parts of the central North Sea. The area of greatest frequency is in the vicinity of the Orkney Islands and the Pentland Firth, but the larvae occur with considerable uniformity along the east coast of Scotland from the Moray Firth to the Firth of Forth.

CONSERVATION IN EVOLUTION.—We have often had occasion to wonder at the apparent wastefulness of Nature, not so much in the winnowing, which casts so many individual lives as nothing to the void, as in the obliteration of fine types which were masterpieces in their day, and leave no direct descendants behind them as the legatees of their splendid qualities. But against this we have to place the great fact of conservation, that there is in a striking way a holding fast to that which is good. Thus we find that particularly effective modes of vital behaviour, some of which made a temporary fortune in their day, yet did not in the end save their possessors from utter ruin, have been caught up by collateral relatives and handed on as a legacy from very ancient days to the higher animals. Let us take a single illustration. Where would a higher animal be, what possibility of such a life would there be, were there not a persistence of that most primitive manifestation of life which we call amoeboid movement—the ebb and flow of a protoplasmic tide within the cell—so familiar to students of biology in Amoebae and white blood-corpuscles? How long would a higher animal survive without its bodyguard of phagocytes? Nor could it have become what it is had not its embryonic neurones flowed out into nerve-fibres, just like exploring Amoebae! It is very interesting that the only animal types without wandering phagocytes are the Nematode worms (some of which, at least, have stationary phagocytes) and the Lancelets. The Nematode worms do not seem to lead on to anything else; and the Lancelets, though near the base of the vertebrate branch, are specialised types in a cul-de-sac of their own. It is surely significant that man himself in the development of his nervous system, in the repair of an abrasion of the conjunctiva covering the front of his eye, in the everyday resistance of phagocytes to intruding Bacteria, and in every inflammation, serious or trivial, harks back in his cellular activities to the Amoebae gliding along on the mud of the pond.

THE BREEDING OF THE SALAMANDER.

The following interesting notes are extracted from a letter of Mr. Arthur C. Banfield. They refer to a Salamander which is now in the Reptile House at the Zoölogical Gardens.

"In April, 1909, I bought for my vivarium two Salamanders (*S. maculosa*): one of these died eight days later. The other was a well-marked, healthy specimen that thrived very well.

"Rather over two years later (in May, 1911) one night I saw that the Salamander was very uneasy, running to and fro restlessly, and then all at once it started bringing forth progeny. In three-quarters of an hour eleven were born miniatures of the mother, except in the possession of gills. Three were devoured by a toad, and I rescued the rest and reared them in a separate case.

"I knew that Salamanders were viviparous, of course; but how was the mother fertilised? I imagined that these animals were far too high in the scale for parthenogenesis, but this is the only explanation I can think of. Perhaps your readers have heard of similar cases."

We are reminded, by this note, of the delayed gestation of the Badger.

PROTECTIVE CHANGES OF COLOUR IN ANIMALS.

(A New Theory.)

By E. Britton.

According to Dr. R. F. Fuchs, of Breslau, the changes of colour which are observed in the chameleon and other animals are not due to any attempt at imitating the colour of the surroundings in order to protect them from their enemies, but represent an effort to regulate the temperature of the body by making use of the different absorptive powers of the various colours for heat. His arguments are certainly very ingenious. He points out that mammals and birds possess these cells, but are unable to effect any change of colour by their means, the reason being, in his opinion, that by the aid of their sweat-glands they are able to keep the temperature of the blood within proper limits, by reason of the large amount of heat rendered latent in evaporation. It was asserted by Rubner that the primary necessity for animals is to prevent overheating of the blood by the continuous chemical changes of the body, and it is upon this theory that Professor Fuchs works. The changes of colour in such animals as the chameleon are effected by means of cells, called chromatophores, situated in the cutis, and filled with pigment of various colours. These cells are capable of enlargement or contraction when they undergo changes of colour. Following out the theory of Rubner, Professor Fuchs points out that these chromatophores exist as active cells in cold-blooded animals alone, and that in no case is a warm-blooded animal by their means, even if possessing chromatophores, able to effect any change of colour.

In mammals, as man, for instance, the cooling of the blood takes place by evaporation from the skin of the body, but this process cannot subsist among the fishes and aquatic animals. Accordingly, if the theory be true, it is here that we must look for instances of colour change; and it is here, in such animals as the goby or squid, that we actually find it. But the most striking argument brought forward is the fact, according to the Professor, hitherto quite unnoticed, that in the great phylum Arthropoda it is only the marine crustacea that are able to effect a change of colour, while the genera living on the land (myriapoda, insecta, spiders) are totally devoid of this power, contact with the air sufficiently enabling them to regulate the heat of the blood.

The chameleon itself, the best known of all the colour-changing animals, and the first one that springs to everybody's mind, certainly seems at first sight to be a contradiction of the Professor's theory, since, although a cold-blooded animal, it lives in free contact with air, and apparently has every opportunity to secure due evaporation; but on examining the matter more closely it is found that the scaly, or armour-plated, reptiles are not in this respect to be compared with mammals or birds, for their skin covering effectually prevents contact with air; and, even if it were not so, these animals in every case, either entirely or almost entirely, lack the cutaneous glands necessary to achieve the purpose.

Amphibia, again, show transitory colour-change; but this is also explained by the fact that the larvae are always aquatic, and even after having become full-grown haunt, for a greater or shorter length of time, moist places, where evaporation from the skin is more or less checked. Similarly, the increase of colour of certain animals at breeding time is explained by the necessity of greater animal heat at this period.

So far, then, the theory stands as a very fair attempt to account for the facts, but unfortunately objections are disposed of rather summarily. It is hard to see why, on such a theory, animals should in any way take on the colour of their surroundings; but, instead of dealing with the difficulty, the Professor dismisses it with a single sentence as due to reflection. The matter may seem to him a very simple one, but it certainly deserves better treatment for those who are not already convinced of the truth of his theory. Further, a theory must be made consonant with other facts, and it is plain that when an Arctic fox or a stoat takes on its summer dress it is not that heat is a factor in deciding the colour; for then it would be more probably white in summer, to reflect the rays of the sun, and keep cool. Admittedly, the colour of fur is not the same thing as the colour of pigment-cells or chromatophores, but the protective theory is consonant with both series of facts, and therefore, other things being equal, receives a prior right to our support. Nevertheless, facts of such weight as have been brought forward by Professor Fuchs decidedly require an answer.

CORRESPONDENCE.

HAMPSTEAD SCIENTIFIC SOCIETY.

To the Editors of "Knowledge."

Sirs,—Students and lovers of nature have only too much reason to fear that the rapid development now going on in the country between Hampstead, Willesden, Hendon, Finchley, Muswell Hill, and Hornsey may mean the speedy extermination or enforced retreat of the majority of the animals and plants which have hitherto contributed so largely to the charm and interest of the neighbourhood

An effort is now being made, on the initiative of the Hampstead Scientific Society, to compile, before it is too late, a complete record of all the natural species still to be found within three miles of the flagstaff on the summit of the Heath. In the book which the Society published last year on "Hampstead Heath, its Geology and Natural History," were collected all the available records of species observed down to 1912. The result must have been a revelation to many of the residents in the district. How many, even of the older inhabitants, had suspected that the list of local mammals includes badgers, hares, hedgehogs, squirrels, and six kinds of bats; that the wanderer on the Heath may come across lizards and snakes; that the ponds and the Brent contained eight kinds of fish, besides microscopic creatures uncountable; that a list of three hundred species of flowering plants has to confess to incompleteness, even when added to one hundred and ninety-three kinds of trees; that two hundred and seventy different birds have been recorded within the three-mile radius; that a Cambridge University lecturer on botany can fill twenty-six pages with a "brief sketch" of the vegetation of the Heath and woods; and that even the varieties of molluscs (slugs and snails and pond mussels) run into three figures.

May I urge upon your readers the importance of these and similar records, as, for instance, those of butterflies, moths, mosses, and fungi, being completed and kept up to date while there is yet time, not only for the sake of scientific knowledge, but also in the hope that the interest thus aroused may do something to foster the preservation of the species that still remain?

Any residents within the district who are willing to assist, either by reporting casual observations or by joining in definite local surveys or schemes of research, are invited to communicate with the Honorary Secretaries of the Society at 32, Willoughby Road, Hampstead. It need hardly be added that the coöperation of other Natural History Societies, in a combined effort to cover the ground, would be most gratefully welcomed.

W. M. FLINDERS PETRIE,
President.

PERFUMES OF LICHENS.

*To the Editors of "*KNOWLEDGE.*"*

SIRS,—Allow me to call attention to the following inaccuracies in the Chemistry Notes on "Perfumes of Lichens" in "KNOWLEDGE" (Vol. XXXVII, March, 1914, page 113). "Other *lichens* containing odorous principles," and so on, should read "other *plants*," and so on. *Conocephalus conicus* is an hepatic, and *Hygrophorus agathosmus* (not *agathosus*) is a fungus. Many of the fungi contain odorous principles.

T. B. ROE.

9, YORK PLACE,
SCARBOROUGH.

FOLK-LORE MUSEUMS.

*To the Editors of "*KNOWLEDGE.*"*

SIRS,—I notice your contributor, Mr. W. Ruskin Butterfield, refers to the fact that doubts have been expressed as to whether the proposal for a British Folk-lore Museum has not come too late in the day for effective fulfilment. He also opines that with regard to folk-lore material museums have hitherto neglected it or treated it with scant regard, and says: "The eyes of Curators have been fixed in the ends of the earth, and the objects illustrating the culture-history of our own people have, for the most part, been overlooked." Had Mr. Butterfield been writing some years ago, there might have been some justification for the statement; but as one who is fairly familiar with most of the museums in this country, and their publications, I can assure him that folk-lore is by no means neglected. In fact, many of these institutions, especially during the past decade, have made a strong feature of such exhibits. It is admitted that in a few places there still may exist examples of the old-fashioned type of so-called Curator, who wears long hair and a chronic semi-imbecilic expression, and seems to use his energies in offending possible donors; but they will all die in time. The pity is that our laws will not enable us to stuff one to be placed among the "bygones" section of a folk-lore museum.

Of course, it is quite possible that some may consider that the day has gone by when sufficient material could be collected for the purpose of a folk-lore museum. It is also possible—in fact, probable—that there are those who consider that all museums are useless; but surely such opinions and those who express them are unworthy of consideration.

If one or two museums to-day may not be devoting sufficient attention to folk-lore, there are plenty of private individuals who are sufficiently intelligent to do so, and their collections will doubtless eventually find their way into some public institution. There is as yet no shortage of suitable exhibits, though it is admitted they are daily becoming more difficult to secure.

T. SHEPPARD.

THE MUSEUMS,
HULL.

REVIEWS.

ARCHAEOLOGY.

Prehistoric Times.—By the late RIGHT HON. LORD AVEBURY, D.C.L. Seventh edition. 623 pages. 283 illustrations. 9-in. × 6-in.

(Williams & Norgate. Price 10/6 net.)

Lord Avebury will be remembered for many things, but honour is due to him very particularly for the interest which he aroused in prehistoric antiquities, and his recognition of the various stages of culture which they represent. His book, entitled "Prehistoric Times," brought before the public Lord Avebury's ideas on the subject, and the volume under consideration is the seventh edition, which was thoroughly revised by Lord Avebury shortly before his death. The work has been entirely reset, and a number of new illustrations has been introduced. To those who have not had the pleasure of studying any previous edition we may say that from the book they will gain a very clear insight into the habits, work, and artistic expression of our remote ancestors who flourished before the time of written history. W. M. W.

BIOGRAPHY.

Lord Lister: His Life and Work.—By G. T. WRENCH, M.D. 379 pages. 4 illustrations. 9-in. × 6-in.

(T. Fisher Unwin. Price 15/- net.)

"A scientist's public life lies in the work that is his," says Lord Lister in the life of his father in the "Dictionary of National Biography," and Dr. Wrench has kept this maxim well before him in the Biography he has written. The details of Lister's private life are few and scanty, but the description of his scientific observations and the terrible condition of the surgical wards of hospitals in the first half of the nineteenth century that called for them are clearly and graphically told. The story reads like a novel, and, while we are bound to confess that the whole work is ably written, particularly is this the case with the earlier chapters of the book.

It is false to say that Lister stumbled on a great discovery, as we are sometimes told. Dr. Wrench tells us how slowly, laboriously, and step by step the causes and prevention of septic decomposition in wounds were discovered,

and explains that the whole of the principles of the present antiseptic treatment of wounds is due to the genius of this truly great man. With all this we gladly acquiesce, but when Dr. Wrench, in one of his later chapters, takes up forty-five pages to endeavour to prove that with the death of Lister all possibility of progress in the antiseptic treatment of wounds suddenly ceased, we are bound to disagree; nor can we help feeling that Lord Lister himself, who possessed the humility which is always associated with true genius, would equally readily repudiate the claims of infallibility set up for him by his biographer, and would be one of the last to assent to the proposition that, "when progress follows upon the work of one of the world's great men, my anticipation is that it will be progress downhill." Nevertheless, the book is really a good one, and its literary style is excellent. It is the best biography of Lord Lister that has yet appeared.

S. H.

CHEMISTRY.

Studies in Water Supply.—By A. C. HOUSTON, D.Sc., M.B., C.M. 203 pages. 43 illustrations. 9-in. × 6½-in.

(Macmillan & Co. Price 5/- net.)

The readers of "KNOWLEDGE" will be familiar with the work of Dr. Houston, for an outline of the main features of his Reports to the Metropolitan Water Board has been published each year in these columns. The present volume is intended not so much as a treatise upon water supply as to embody the results of the author's personal experience and investigations, which have hitherto been scattered in various publications. At the same time a large amount of more general information is necessarily included.

The subjects discussed include the use of rivers as sources of supply, processes of purification and sterilisation, the effect of storage upon bacteria, and the question of water-borne disease and endemic typhoid; while the later chapters deal with practical bacteriological methods and statistical information. The book is well illustrated with diagrams, figures of apparatus, and photographs of algal growths, and has a particularly full index.

It is not too much to say that this monograph is absolutely indispensable to all who have to examine water, or whose business it is to ensure a pure water supply. A copy of it should be upon the shelf of every chemist and every municipal engineer.

C. A. M.

ENTOMOLOGY.

A Textbook of Medical Entomology.—By W. S. PATTON and F. W. CRAGG. 745 pages. 89 plates. 10-in. × 7½-in.

(Christian Literature Society for India. Price 21/- net.)

The authors set out to "compile a guide to the study of the relations between Arthropods and disease, rather than a textbook of entomology." We think they have succeeded, but we wish the title had conveyed this clearly, and not given the impression that it was a textbook. Clearly, it is more a laboratory guide than anything else, and the medical officer who sets out to learn his entomology from this volume will become even more the one-sided "medical" entomologist than the average combination of medicine and entomology is at present—one can say nothing stronger.

The volume contains 745 pages and 89 plates, the latter rather coarse line or half-tone drawings, many of which would have been better in the text and considerably reduced. The amount of information in the book is prodigious, and we strongly commend it to all medical officers in parts of the world where libraries do not exist, and who want a plan of the construction of the various flies that are of importance in connection with disease. It includes not only flies, but bugs, lice, fleas, ticks, mites, tongue-worms, and water-fleas. The systematic part whereby species will be recognised will soon be useless, as the fauna of no part of the world is so well known that new species will not be found, at once rendering this section misleading; the rest will remain as an extremely valuable summary of a very complex subject, of permanent value as a reference laboratory manual, and one that is a notable advance in this subject. The authors write clearly, and obviously describe what they themselves do: their methods are simple and efficient, and of the greatest assistance to those placed in similar circumstances who have not their experience.

In addition to a minute account of the anatomy, the authors give detailed descriptions of the methods of keeping in captivity the many blood-sucking insects with which they deal. This is perhaps the most valuable part of the book, and one that will be of the greatest use to those who wish to breed and study insects they may think are connected with the transmission of disease. The volume will not assist those who wish to study the living insect in the field; it is a laboratory manual in which only those things are dealt with which concern the laboratory student; it does not deal with prevention or check, as its title may lead some to expect.

We congratulate the authors on a very remarkable work, the more so when one knows the adverse conditions of climate with which they had to contend. It is an illuminating commentary also on the possibilities there are for men keen on investigation to go to India, for nowhere else perhaps could men get the time, the material assistance, and the inducements to perform such work as is possible under the enlightened policy (in these times) of the Indian Government.

When a fresh edition is required we hope the authors will condense the descriptions of species or omit them in favour of keys, leave out matter such as that on page 177, and reproduce their illustrations in a less coarsely diagrammatic manner.

H. M. L.

GEOGRAPHY.

Northumberland.—By S. RENNIE HASELHURST, M.Sc., F.G.S. 181 pages. 63 figures. 7 maps. 7 diagrams. 7½-in. × 5-in.

(The Cambridge University Press. Price 1/6.)

The little volume dealing with Northumberland in the series of Cambridge County Geographies is quite as interesting as its fellows. The chapter on Natural History calls for particular attention, for Northumberland includes the Farne Islands, with its wonderful wealth of bird life; while in Newcastle is the celebrated Hancock Museum, and there have been plenty of naturalists to work out the flora and fauna of the county. There is a full account of the Roman remains under the heading of Antiquities, and on the roll of honour we find the name of John Blenkinsop and George Stephenson; while, besides the brothers Hancock, whose museum has been mentioned, there are Joshua Alder and Thomas Belt, the author of "The Naturalist in Nicaragua."

W. M. W.

HORTICULTURE.

The Horticultural Record.—Compiled by REGINALD CORY. 500 pages. 96 plates. 71 figures. 12-in. × 9¼-in.

(J. & A. Churchill. Price 42/- net.)

The International Horticultural Exhibition of 1912 was such a triumph that this present sumptuous volume forms a fitting permanent record of the occasion. It is more, however, for it gives an account of the progress which has been made in the horticultural art since the first international exhibition, held in the year 1866. Many of the coloured plates, taken from photographs by the three-colour process, are exceedingly beautiful, and when one remembers that the exposures had to be made against time, as it were, in adverse circumstances very often, and in tents where there was insufficient light, we think that those concerned are very greatly to be congratulated. As may be imagined, there are full details as to the awards made; but the book also includes reports on horticultural education, on the conference held upon this important subject, as well as much information with regard to legislation in connection with plant diseases. Every serious student of horticulture should add this book to his library, in order to take pleasure from turning over its pages, and to gain profit by using it as a work of reference.

W. M. W.

PHYSICAL GEOGRAPHY

The Improvement of Rivers (Parts I and II).—By B. F. Thomas and D. A. Watt. 369 pages 76 plates. 249 figures. $11\frac{3}{4}$-in. $\times 9\frac{1}{4}$-in.

(Chapman & Hall. Price 31/6, 2 vols.)

The proper use of rivers is a problem that this country has hardly taken the trouble to solve, partly, of course, because the most of our English rivers are of comparatively small importance, and partly because the law relating to ownership and responsibility is in a very unsatisfactory condition. In the United States of America, where the rivers are all important to the country's welfare, conditions are different, and it is not surprising to find that "The Improvement of Rivers," by Messrs B. F. Thomas and D. A. Watt, has reached a second edition. It is issued in two bulky volumes by John Wiley & Sons of New York and Chapman and Hall in London. The work has been done well and in comprehensive fashion, starting with a study of the characteristics of rivers and passing to all the work by which man can guide and regulate the flow of water to his best advantage. The cost of dredging has been studied the world over; the protection of banks and the questions relating to storage reservoirs will be found full of interest to those who have any interest in river control, and find themselves face to face with the need for accurate modern information. But it is the study of canalisation that bears most directly upon this country's interests at a time when the question of reviving the use of canals that have been allowed to fall into disuse is being considered seriously. It may be said that no problem of construction or maintenance has been overlooked, and in search of material the authors have cast a very wide net, and have secured a remarkable series of sketches and diagrams. One would like to see a greatly condensed and inexpensive edition of this work published in England: it might go far to remind local authorities of the existence in our midst of a source of revenue and convenience that is well-nigh overlooked to-day. We have very few rivers that may be said to be worth a tithe of the expenditure involved by most of the operations that Messrs. Thomas and Watt describe, but we have scores of small rivers that seem to serve no more useful purpose to-day than to make the surrounding country impassable upon occasion. Perhaps if our lesser rivers had a commercial importance they would receive some attention; at present their neglect is little less than a scandal. It may be remarked that the authors, in writing of English waterways, limit their brief remarks to the river Thames and the Manchester Ship Canal.

S. L. B.

SPECTROSCOPY.

Index of Spectra, Appendix V.—By W. Marshall Watts, D.Sc.(Lond.), B.Sc. (Vict.), late Senior Science Master in the Giggleswick School. 92 pages. $8\frac{1}{2}$-in. $\times 5\frac{1}{2}$-in.

(W. Wesley & Son. Price 12/6. Post free.)

One of those pieces of work like Bradley's and Groombridge's list of the places of the stars that are the foundation-stones on which cosmology is built.

It gives on one uniform standard scale the work of many investigations from all countries, and also references to a large number of books.

The lines of the spectra tabulated are those of Air, Aldebaranium, Aluminium, Alumina, Ammonia, Antimony, Argon, Arsenic, Barium, Beryllium, Bismuth, Boron, Bromine, Cadmium, Caesium, Calcium, Carbon, Cassiopeium, Cerium, Chlorine.

The surprising accuracy of modern work is well exhibited In cases where sometimes half a dozen or more observers' results are classified scarcely any cases occur where the results are more than a single A.U. out.

Some of the work has not been previously published. A fairly successful attempt has been made to associate the lines with formulae, and, although some of the formulae may be but empirical, yet they show law and order is at work. Especially fine is the regularity of the bands of cyanogen.

The work of some fifty observers and experimentalists is classified. One cannot help noticing the industry of Professor Fowler: it is not long ago that he solved the problem of Secchi's third-type stars that for so many years were enigmas to astronomy, and showed them to be due to titanium oxide. Quite recently he showed clearly the absolute coincidence of the spectra of a comet with that of carbonic oxide. A large amount of both his published and unpublished work is contained in this index. Amongst the many names one sees a good deal of the work of such well-known names as Deslandres, J. J. Thomson, Rayleigh, Duffield, Eder, and Valenta.

A. W. B.

NOTICES.

NEW SCIENTIFIC BOOKS.—In Messrs. Macmillan's new list of forthcoming books for April there is a number dealing with science and education which are of interest to our readers.

BLACK'S "MEDICAL DICTIONARY"—The "Medical Dictionary," edited by Dr. Comrie, is a standard work for the layman, and a new edition of it is promised in which many improvements will be made.

GUIDE DEMONSTRATORS.—The progress of the movement in favour of the appointment of official guides at Government institutions is indicated by the announcement that there is now one on the staff of the National Gallery of British Art, Millbank Applications for special guidance should be sent to the Official Guide, care of the Keeper.

THE PEOPLE'S BOOKS.—Messrs. Jack announce another six volumes in their "People's Books" Series. These are as follows: "Bacteriology," by W. E. Carnegie Dickson, M.D.; "Anglo-Catholicism," by A. E. Manning-Foster; "Robert Louis Stevenson," by Rosaline Masson; "Canada," by Ford Fairford; "Tolstoy," by L. Winstanley, M.A.; and "Greek Literature," by H. J. W. Tillyard, M.A.

INTERNATIONAL CONGRESS OF TROPICAL AGRICULTURE.—The Third International Congress of Tropical Agriculture will be held in London at the Imperial Institute from June 23rd to June 30th, 1914. A copy of the members' circular which has reached us gives lists of the papers which have been promised, and of the associations and countries which are sending delegates or representatives. All particulars can be obtained from the Organising Secretaries at the Imperial Institute, London, S.W.

SECOND-HAND INSTRUMENTS.—Mr. C. Baker has favoured us with a copy of his classified list of second-hand instruments, which will be sent post free from 244, High Holborn, to any applicant. The list contains descriptions of nearly two thousand pieces of scientific apparatus, and includes a very fine selection of modern microscopes, objectives, telescopes, and spectroscopes, from which anyone who has need of such apparatus can hardly fail to be able to make a choice.

HULL MUSEUM PUBLICATIONS.—The quarterly list of additions for the Hull Museum edited by Mr. Thomas Sheppard has reached us, and, as usual, contains matters of considerable interest to the student of antiquities, as well as a paper by the Editor on "The Chalk Fossils in Hull Museum" We note an account of an experiment, recently tried by the Curator, of personally conducting parties round

the Museum. Those who know Mr. Sheppard will not be surprised to hear that his efforts have been very successful, and that the experiment will be continued.

CAB SIGNALS AND TRAIN STOPS.—Mr. William H. Dammond is continuing, in *The Railway News*, his articles on direct signalling to the drivers of trains. He says that unless the cab system gives three distinctive results—"clear," "run slow," and "stop"—it is not worthy of adoption or test. Important as it is to send a clear signal for any given train, it is exceedingly more important not to give that signal to another train. Mr. Dammond discusses three general classes of signalling before the public to-day. They are all electrical, and are as follows: Wireless, contact bar, and the ramp type.

MEDICAL AND SCIENTIFIC CIRCULATING LIBRARY.—We have received from Mr. H. K. Lewis the second supplement to the catalogue of his Medical and Scientific Circulating Library, which, apart from the index and contents, occupies ninety-six pages. The original catalogue, which was revised at the end of the year 1907, together with the first supplement, may be obtained by subscribers for 2/-. For the benefit of those students who are wishful to read books that they do not care to keep we may mention that the address of Lewis's Library is 136, Gower Street, London, W.C.

PHOTO-MICROGRAPHY.—Those who are anxious to become familiar with the art of photo-micrography should make a point of attending the six practical demonstrations which Mr. Edgar Senior will give at the South-Western Polytechnic Institute, Chelsea, on Monday evenings, beginning on May 4th, 1914. At the demonstrations special attention will be given to the Photographing of Etched Surfaces of Metals and Alloys (Metallography), but the course will also be arranged to suit the requirements of students of Geology, Botany, or Zoölogy, and of those wishing to use their own microscopes to obtain photographic records of objects.

THE PRINTING EXHIBITION.—The Printing and Allied Trades Exhibition, to be opened at the Royal Agricultural Hall by the Lord Mayor of London on May 13th, promises to be of exceptional interest. It will be the largest and most representative Exhibition of its kind ever held in any part of the world, every available space in the Great Hall, the Gilbey Hall, King Edward's Hall, and the Galleries being occupied with exhibits strictly appertaining to the graphic arts; new machinery and appliances will be shown, alike interesting to the expert and the general public, in addition to a very fine display of specimens of printing by all processes, including photogravure. The Exhibition will remain open until May 30th.

ADDITIONS TO THE MENAGERIE OF THE ZOÖLOGICAL SOCIETY.—In March, the registered additions to the Zoological Society's Menagerie were one hundred and nine in number. The following may be specially mentioned: Two Grévy's Zebras (*Equus grévyi*), ♀♀, from Abyssinia, purchased on March 2nd; three Indian Antelopes (*Antilope cervicapra*), presented by H.M. the King on March 2nd; one Eland (*Taurotragus oryx*), ♀, born in the Menagerie on March 3rd; one Ibean Potto (*Perodicticus ibeanus*), new to the Collection, deposited March 2nd; two Blue-cheeked Amazon Parrots (*Chrysotis versicolor*), from St. Lucia, presented by E. J. Cameron, C.M.G., on March 2nd.

HAMPSTEAD SCIENTIFIC SOCIETY.—The excellent work which the Hampstead Scientific Society is doing is recorded once more in the report for the year 1913, which has just been issued. The fact that the South Eastern Union of Scientific Societies held its congress at Hampstead last summer made the past year memorable, and the book entitled "Hampstead Heath, its Geology and Natural History," prepared by members of the Society, will be a lasting record of the Society's energy. The report contains abstracts of papers read before the Society as a whole and before the sections. It is hardly necessary to remind our readers of the Astronomical Observatory maintained by the Society, or the Meteorological Observations which are regularly made there.

MR. MURRAY'S QUARTERLY LIST.—Among the forthcoming works which will be published by Mr. Murray, as announced in his quarterly list, are the following, which will be of interest to our readers:—"Life and Human Nature," by Sir Bamptylde Fuller, K.C.S.I. (this work is an attempt to construct a natural history—or science—of human nature by tracing behaviour of mind or body to impulses which actuate, more or less definitely, all living creatures, and may be regarded as life's manifestations of itself); "Concerning Animals," by E. H. Aitken; "Nature and Nurture in Mental Development," by Dr. F. W. Mott (this book is an expansion of the Chadwick Public Trust Lectures of 1913); and "Researches into Induced Cell-Reproduction in Amoebae," by John Westray Cropper, M.B., M.Sc.

THE UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.—We notice, in the list of special arrangements for May, the following items, which are of interest to our readers: Monday, May 4th, at 10 a.m., "Carbon Assimilation and Respiration," first of a course for botany students, by Dr. Sarah M. Baker; Monday, May 4th, at 3 p.m., "Advanced General Psychology," first of an advanced course, by Dr. Aveling; Tuesday, May 5th, at 5 p.m., "The Ethnology and Pathology of the Ancient Egyptians," first of a course of four public lectures, by Dr. D. E. Derry; Tuesday, May 5th, at 6 p.m., "Computing, and some Mechanical Aids to Calculation," first of a course of six lectures, by Mr. H. E. Soper; Thursday, May 21st, at 2.30 p.m., "Recent Discoveries in Egypt," public lecture introductory to a course, by Professor Flinders Petrie.

THE THEORY OF THE THIRD BODY.—The London Astronomical Society, as a result of a motion proposed by Mr. J. H. Worthington, M.A., F.R.A.S., has issued a statement regretting the failure of official observatories to use Professor Bickerton's generalisation—the "Impact Theory of Cosmic Evolution"—as a working hypothesis, and saying that, because this efficient correlation is not taught in our seats of learning, scientific progress has been seriously retarded. If the theory of the third body be wrong, it is the duty of the guardians of scientific knowledge to point out its fundamental errors before it is generally accepted. If no basic error can be found, then its proven capacity as a working hypothesis should justify its being taught and used. All communications to be addressed to the Secretary of the London Astronomical Society, 18, Pembridge Mansions, Moscow Road, Hyde Park, W.

THE BINOCULAR MICROSCOPE.—We have received from Mr. Leitz a copy of a paper by Dr. Jentzsch on the subject of the binocular microscope, which is reprinted from *The Journal of the Royal Microscopical Society*. In it the whole subject of binocular microscopes is reviewed, and special attention given to the new type introduced by Mr. Leitz. This is the first successful binocular instrument made for use with all ordinary objectives and eyepieces, including the high powers. Mr. Leitz points out that his new microscope is capable of being used for all purposes to which the binocular is put, and with equal results. Another most important feature and advantage of the instrument is that the research worker can use his eyes for very much longer without strain, and it is likely that by the use of the new binocular many microscopists who would otherwise have to leave off using their instruments will be able to continue their researches.

THE ROYAL INSTITUTION.—At a meeting of the members of the Royal Institution, held on the afternoon of April 6th, the Duke of Northumberland (President) announced that the septennial award under the Acton Endowment had this year been made to Professor C. S. Sherrington,

Waynetlete Professor of Physiology in the University of Oxford, for his important work entitled "The Integrative Action of the Nervous System," being a synopsis of his elaborate paper published in the Philosophical Transactions of the Royal Society on Experiments in Examination of the Peripheral Distribution of the Fibres of the Posterior Roots of some Spinal Nerves. Previous Actonian awards have been made to Sir George Stokes, Miss Agnes M. Clerke, Sir William and Lady Huggins, and Madame Curie, for achievements in the field of physical science. Professor Sherrington is the first investigator in Experimental Biology to receive this distinction for the third of a century.

A DEFENCE OF ADVERTISING.—A book of equal interest to the business man and social student will shortly be issued by *The Review of Reviews*. Its title is "Advertising and Progress," and its authors are Mr E. S. Hole, who was intimately associated with the late W. T. Stead, and Mr. John Hart. It is the object of the book to demonstrate that the social service rendered by advertising immeasurably exceeds its cost. It goes on to prove that, far from being an extra charge on the consumer, it enables the public to effect hitherto impossible economies. It contends that the charge of advertising falls on the obsolete and obsolescent costly selling methods which it displaces. The book is provided with an array of statistics, diagrams, facts, and arguments, but the authors have written from a standpoint which will retain for them the interest of the general reader. It is a careful and reasoned defence of advertising which will evoke much discussion among students and critics of that much maligned but rapidly developing institution.

THE BRITISH GEOMETRIDAE.—For the last six years Mr. F. N. Pierce and the Rev. C. R. N. Burrows have been studying the genitalia of the British Geometridae, and the plates and letterpress of their book on the subject are now in the hands of the printers. The work is illustrated by 1570 outline drawings of the genital parts of practically every recognised British species. The writers have attempted a classification based entirely on the genitalia, which, in many cases, helps to confirm the latest systems where other structures have been considered. Nothing of the kind has ever been attempted with the British Geometridae before, and the exceeding beauty of the structures will come as a surprise to many who only know Lepidoptera by their wing-markings.

We are pleased to echo the appeal of the authors for a large number of subscribers. For copies ordered in advance seven shillings and sixpence will be charged. The published price is ten shillings net. Orders should be sent to Mr. Pierce, "The Elms," Dingle, Liverpool.

ROTHAMSTED EXPERIMENTAL STATION.—The annual report for 1913 of the Lawes Agricultural Trust has been issued, and from it we learn that the Lawes and Gilbert Centenary Fund is not yet closed, there still being £950 to raise before the new laboratories can be built. The Centenary Fund was established for the purpose of collecting £6000 whereby to qualify for a Development Grant of £6000, and thus obtain a sum sufficient to erect and equip a laboratory at Rothamsted to replace the old laboratory, which, after nearly sixty years of use, is now too small and unsuitable for modern requirements. The fund has been generously supported, subscriptions, large and small, having come in from Great Britain and Ireland, from France, Belgium, Holland, Germany, Spain, Canada—where the Federal Government gave five hundred dollars—United States, India, and Australia. The Committee is particularly anxious to clear off this last sum, and to begin building operations at an early date. Subscriptions should be sent to the Secretary, Rothamsted Experimental Station, Harpenden, Herts.

THE INSTITUTE OF METALS: MAY LECTURE. Professor E. Heyn, of Berlin, will this year deliver the annual May Lecture before the Institute of Metals. Professor Heyn, who has made a life-long study of the subject, has given the title of his discourse as "Internal Strains in Cold Wrought Metals, and some Troubles caused thereby." The Institute of Metals is fortunate in its May Lecturers and in the natural sequence of the subjects dealt with at these lectures. Thus, the last May Lecture, by Sir J. Alfred Ewing, K.C.B., F.R.S., was on the subject of "The Inner Structure of Simple Metals," and previously Dr. G. T. Beilby, F.R.S., had lectured on an allied subject, "The Hard and Soft States in Metals." Professor Heyn's discourse will be given in the building of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W., under the chairmanship of Admiral Sir Henry Oram, K.C.B., F.R.S., the President of the Institute of Metals, on Tuesday, May 12th, at 8.30 p.m. The Secretary of the Institute, Mr. G. Shaw Scott, M.Sc., of Caxton House, Westminster, S.W., will be glad to forward tickets to any readers who may desire to be present at the May Lecture.

ANTHROPOID APES IN CAPTIVITY.—At the meeting of the Zoölogical Society of London, held on April 17th, Dr. Mitchell exhibited the photograph of a female Orang-utan (*Simia satyrus*), kindly sent to him by Mr. W. H. D. Le Souëf, the Director of the Zoölogical Gardens at Melbourne. According to the statement of Mr. Le Souëf, this Ape had lived in the Gardens at Melbourne for twelve years in an open-air enclosure attached to a shelter without any artificial heat. Dr. Mitchell said that Orangs were notoriously difficult to keep alive in captivity, and even in Singapore they seldom lived for two years after capture. Mr. Le Souëf's example was certainly extremely interesting. In the Society's own Gardens, a fine male Orang, obtained on September 7th, 1905, was still alive, and it was reported to have been in captivity for eight years before it came to London, so that it was still older than the Melbourne example, and had shown the cheek-plates for the last two years. Chimpanzees were less delicate, but the average duration was not good. The Chimpanzee known as "Mickie," which had been purchased by the Society on April 6th, 1898, was still living, and certainly was the Anthropoid Ape known to have lived longest in captivity. The almost universal experience with Gorillas was that they lived only a few weeks after reaching Europe, and, in consequence of this high mortality, the Secretary had for some years declined to encourage importers by refusing to buy. In one Continental collection, however, a Gorilla had lived for several years.

THE ALCHEMICAL SOCIETY.—The twelfth general meeting of The Alchemical Society was held on April 17th. The chair was occupied by Mr. Arthur Edward Waite, one of the Vice-Presidents of the Society, whose many alchemical translations and other works are well known, and a very suggestive paper, entitled "Some Reflections on 'Basil Valentine,'" was read by Mr. Philip Sinclair Wellby, M.A. (Cantab). Mr. Wellby called attention to the excellent literary style of "Valentine's" and other alchemical writings—the fine spiritual fervour which suffused them. He maintained that Alchemy was essentially a spiritual process taking place in the soul of man whereby he might become perfected, and capable of controlling the forces of Nature in ways not at present known to science. He supported this bold thesis by quotations from the writings of several modern philosophical thinkers concerning the relations between the worlds of spirit and matter. In the animated discussion which followed Mr. H. Stanley Redgrove, B.Sc. (Lond.), the Acting President of the Society, put forward the counter-thesis that the alchemists were essentially concerned with chemical processes, which they attempted to explain by means of doctrines drawn from the domains of theology, this origin for their theories and speculations making a translation of them into theological terms possible. The full text of the lecture, and a report of the discussion, appears in *The Journal of the Alchemical Society* for April, published by Mr. H. K. Lewis, of 136 Gower Street, W.C., at 2/- net.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

JUNE, 1914.

SOME FURTHER EXPERIMENTS WITH LIQUID DROPS AND GLOBULES.

By CHAS. R. DARLING, A.R.C.Sc.I., F.I.C.

In the issues of "KNOWLEDGE" for February and April, 1913, the author described a number of new experiments with liquids approximating in density to water, with special reference to the formation of spheres, drops, and columns, and the movements of globules on the surface of water. The present article is intended to supplement those which have previously appeared, and will be devoted to a description of some further experiments with the same class of liquids.

WATER SPHERES IN ANILINE SKINS.

At first sight it might appear a difficult operation to enclose one liquid in the skin of another; nothing, however, could be simpler. A layer of aniline is placed at the bottom of a beaker, and covered with water to a depth of about two inches. A glass tube, of bore about one-eighth of an inch, open at both ends, is then inserted in the water, and lowered until the end is submerged in the aniline. (As the tube is open, water will enter it on immersion, so as to stand at the same level as that in the beaker.) On lifting the tube out of the aniline a skin of this liquid adheres to the end; and on raising it further this skin is inflated by the water in the tube, which sinks so as to maintain the common level. In this manner the film of aniline is distended by water, just as a soap-film is blown into a bubble

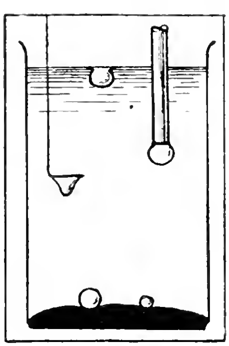
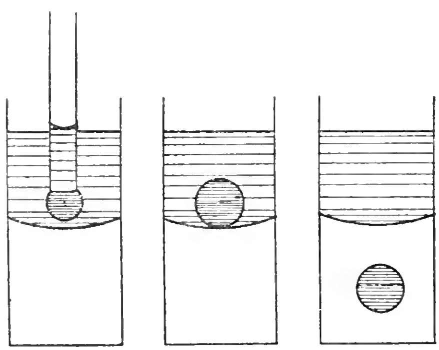


FIGURE 182.
Aniline skins enclosing water.



A B C

FIGURE 183. The "Diving" Drop.

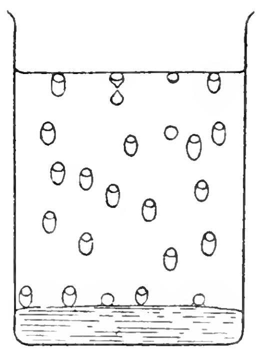


FIGURE 184.
The "Dancing" Drop.

with air. In removing the tube entirely from the water the composite spheres remain clinging to the surface, or may fall through the water to the bottom of the beaker (see Figure 182) If a ring of wire, about three-eighths of an inch in diameter, be dipped beneath the aniline and then withdrawn a flat film will adhere, which may be stretched into the familiar shape of a falling drop by lifting the wire suddenly. Many interesting experiments are possible with these films, which are obtained more readily after the aniline has been in contact with the water for some days.

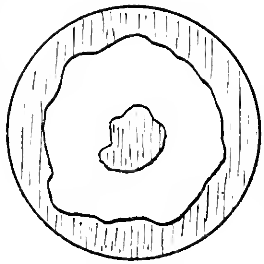


FIGURE 185.
The "Expanding" Globule.

THE "DIVING" DROP.

This experiment illustrates in a striking manner the force with which the surface of a liquid is restored to its normal shape after undergoing distortion. A quantity of dimethyl-aniline is poured on to water to a depth of three-quarters of an inch, and a sphere of the liquid, encased in a water skin, formed as described in the previous experiment (see Figure 183, A). On lifting the tube out of the liquid the sphere falls from the end, and rests on the joining-surface (see Figure 183, B), where it remains for a few seconds, when it suddenly bursts through the interface, and is projected with some violence downwards (see Figure 183, C), the skin of water having now disappeared. The drop—now composed entirely of dimethyl-aniline—then rises to the top of the water, breaks through the surface, and merges into the liquid above.

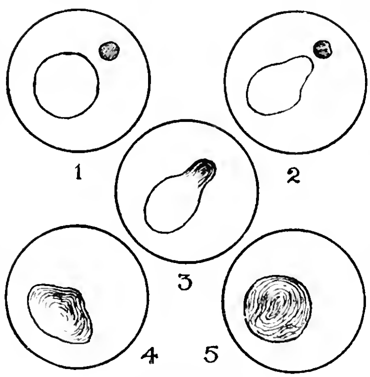


FIGURE 186.
The "Devouring" Globule.

This curious behaviour on the part of the compound sphere admits of a simple explanation. After resting for a time on the interface the under-part of its skin becomes continuous with the water below, with the result that the shape of the surface joining the two liquids is changed, the sides being now connected to the water-skin forming the upper part of the drop. This is an unstable shape for a stretched surface, which always tends to occupy the minimum area; and hence the skin assumes its normal shape, and with sufficient force to cause the drop beneath it to dive into the water to some depth, although dimethyl-aniline is lighter than water, and tends to float. On the sphere rising and breaking through the interface a similar action, in the reverse direction, takes place, but cannot be seen owing to the sphere losing its identity on entering its own liquid.

"Diving" drops can be obtained by using ordinary paraffin oil instead of dimethyl-aniline; the effect, however, is not so well marked.

THE "DANCING" DROPS.

When a volatile liquid is heated beneath a layer of water the bubbles of vapour, on leaving the joining-surface and entering the water, tend to carry with them a portion of the liquid below. This may be seen on heating a layer of chloroform, about half an inch deep, covered by water to a depth of about three inches. The action, however, is much more striking if *monobrom-benzene* be used, as this liquid possesses a higher boiling-point than chloroform. On heating the liquid the vapour bubbles enter the water loaded with a drop of liquid, the amount detached being such as to make the density of the combined vapour and liquid drops about equal to that of water. On rising the drops enter a colder layer of water, which causes the vapour to contract and partially condense, with the result that the drops sink. On reaching the warmer region below, however, the lifting power is restored, and the drops rise again. The appearance of the drops is shown in Figure 184, but the chief interest of the experiment lies in the novelty of the movements. Some reach the surface at once, and there discharge the vapour, when the attached liquid falls; others dance up and down with great rapidity; whilst others, the densities of which are nicely balanced with that of the water, move slowly upwards or downwards. This simple experiment is at once interesting and instructive, and is one in which actual observation conveys far more than a mere description.

THE "EXPANDING" GLOBULE.

A globule at rest on the surface of water is maintained in equilibrium by the operation of three tensions, viz., water-air, liquid-air, and water-liquid, or interfacial. Any alteration in these tensions will disturb the equilibrium and cause the globule to alter in shape. This is shown in a striking manner by floating a globule of aniline on water and dropping into it a small quantity of quinoline, when the globule will be observed to expand violently in all directions, leaving a hole in the centre (see Figure 185). This action is even more intense if a drop of quinoline be placed on a globule of light lubricating oil, when it will be observed that the quinoline sinks through the globule,

without causing any disturbance, until it breaks through the junction of the oil and water, when the globule spreads out with such force as to be broken into several portions. This phenomenon is therefore due to an alteration in the interfacial tension, which now offers less opposition to the pull of the water-air tension on the globule, and hence spreading occurs.

The "Devouring" Globule.

When globules of different liquids are floating on the same water surface a tendency to join together is sometimes noticed, and the same applies to separate globules of the same liquid. This tendency to coalesce with other globules is shown in a marked degree by dimethyl-aniline, and may be utilised so as to give the novel appearance of one globule feeding on another. To show this effect to best advantage a small quantity of orthotoluidine is poured on to a clean water surface, when it breaks up into a number of active globules. A large globule of dimethyl-aniline is then formed on the surface, which at once proceeds to feast upon the orthotoluidine. The procedure is shown in Figure 186, which represents (1) the initial stage; (2) the large globule of dimethyl-aniline sending out a protuberance in the direction of the small one; (3) the small globule incorporated; (4) the protuberance withdrawn, causing a recoil which spreads the large globule laterally; and (5) the globule restored to its proper shape, showing streaks due to the orthotoluidine not being perfectly mixed—an operation which takes a short time, after which the globule becomes clear again. The process is then repeated, one after another of the orthotoluidine globules being absorbed until the surface has been cleared, when the "devourer" comes to rest in the centre of the surface. It is amusing to observe how the small globules sometimes retreat, as if trying to avoid capture, only to be pursued and made to share the common fate. The movements may be seen to better advantage when the surface is magnified by lantern projection, and resemble in a striking manner certain processes associated with life—such, for example, as a white blood-corpuscle (phagocyte) feeding on microbes. And it is interesting to note in this connection that some of the other movements of globules described by the author in previous issues of "Knowledge" show analogies to the movements of the lower organisms; for example, the pulsation of aniline globules and the motion of translation and subdivision of orthotoluidine; all of which only proves, however, that certain phenomena, usually supposed to be inseparable from life, may be produced with inert substances.

CORRESPONDENCE.

SINGLE TIDES.

To the Editors of "Knowledge."

Sirs,—Your correspondent, Mr. R. Shepherd ("Knowledge," Volume XXXVII, April, 1914, page 153), has unfortunately mistaken the locality referred to. It was not Southampton Water that was intended, but Freemantle, in Western Australia, where there is, as stated, but one tide a day. The information given by your correspondent, Mr. A. Stevens, of the Geographical Department, University of Glasgow, is very valuable, and to some extent serves to indicate the astro-geographical causes of the irregularity. If, however, we concede the main cause to be due to the Moon's declination—a factor that is certainly employed in the construction of the Freemantle Tables—we yet have to account for the partiality of this disturbance, inasmuch as the local geographical conditions at Aden and Freemantle (both cited by your correspondent) do not conform with those at Southampton Water, where there are two tides at the syzygies. Similarly, we have to ascertain the causes of the peculiar disturbance of the tides at Aden and Freemantle, on the theory that the Moon's declination is involved. If the astronomical factor $\frac{R.A.(M-S)}{2}$ be allowed, then it appears it should hold universally, and such, doubtless would be the case but for local conditions, such as strong river flows into estuaries, and possibly, also, strong ocean currents. I suggest the latter as applicable to the cases of irregularity cited, and should be glad if any of your correspondents could confirm or correct this view.

W. GORNOLD

South Kensington, S.W.

RUSSIAN PEASANTS' ARITHMETIC.

To the Editors of "Knowledge."

Sirs,—On my way home from India in April a gentleman gave me the following method used by the Russian peasant when requiring the result of two numbers multiplied together without the help of multiplication. It seems so ingenious that I think it may be of public interest, and I shall be glad if you can find a place for it in "Knowledge." Perhaps one of your mathematical readers will explain how the thing is done. Say:

25 × 11	19 × 17	~~16 × 11~~
~~12 22~~	9 34	~~8 22~~
~~6 44~~	~~4 68~~	~~4 44~~
3 88	~~2 136~~	~~2 88~~
1 176	1 272	1 176
275	323	16 × 11 = 176.
25 × 11 = 275	19 × 17 = 323.	

The peasant halves the figures upon the left side, neglecting fractions, and doubles the right side to correspond; then he draws a pen through everything that is even on the left, right across, and adds the total.

The sum comes invariably right for any numbers.

(Rev.) G. T. JOHNSTON.

Trederwyn, The Down,
Bexhill-on-Sea.

THE ZODIACAL LIGHT.

By THE REV. J. T. W. CLARIDGE, M.A., F.R.A.S.

WHAT a remarkable phenomenon is that luminous object in the heavens occasionally seen at this season of the year by the naked eye, and yet incapable of distinct observation by the telescope! Such is the Zodiacal Light. It may be taken for granted that of all the forms which light takes perhaps this can safely be described as the most delicately beautiful. More milky than the Milky Way, more translucent than the filmy nebulae, and not altogether unlike the Aurora Borealis, with which it has sometimes been associated, it seems like the concentrated essence of twilight, shooting up into the sky as the Sun goes down about the time of the vernal equinox, or preceding the Sun as it rises in the autumn. At sunset in March, April, or May, if the atmospheric conditions be favourable, there can be seen a bright tract of the heavens which may be defined as a kind of elongated triangular pyramid or spire resting upon that part of the horizon beneath which the Sun has set. Away from all glare of gas light or electric light, it may be discerned without much difficulty. Of course, there must be no moonlight, nor even the brightness of Jupiter or Venus, to interfere with its view. With regard to its position, for all practical purposes we may say that its axis coincides with the plane of the Ecliptic or of the Sun's equator. This definition, though fairly correct for high latitudes, does not accurately represent it as seen in the tropical regions, where its light is often very conspicuous, and may be seen throughout the year. To an observer in England the cone of light leans somewhat to the left, and lies along the line of the Zodiac. Hence the origin of the name "Zodiacal Light," given by Cassini in 1683. In concord with other celestial objects, it sinks in the west by virtue of the Earth's rotation, thereby showing that its existence is external to the Earth's atmosphere. Pliny, who flourished in the first century of the Christian era, in his writings seems to allude to this phenomenon under the name of "*trabes lucis*" ("beams of light"), and the renowned Kepler (1571–1630) came to the conclusion that the Zodiacal Light was an atmosphere of the Sun. Later on Cassini, who died in 1712, after several years of observations at Nice, remarked that the northern edge of the light leaned more and more from its ecliptical axis during the months of March and April, when the solar equator was increasing its inclination to the Ecliptic, and consequently he concluded that it was a solar appendage. He further described it as having a lenticular shape; that its diameter in June was equal to that of the Sun, but much larger in March. In 1731 Mairan spoke of it as a solar reflection, having the form of a flattened spheroid. Humboldt, in his striking work "Cosmos," gives some very interesting notes on the subject, not the least being, in his opinion, that the ancients were unacquainted with it, notwithstanding the clearness of the eastern sky. From his own observations in South Africa, he describes the light as of a "blazing" character at one time, and as an "exquisitely delicate and ethereal object" at another. The remarkable meteoric shower of 1833 caused a goodly number of speculations as to the composition of the light. By many it was thought at the time that the display was due to the Earth passing through the material of the light. No less a personage than Biot took up this argument, and suggested that the Earth actually passed through the node of this material. About 1852, during Commodore Perry's expedition to Japan, a long series of observations of the light was made by the Rev. George Jones, who was Chaplain on the U.S.A. frigate, the "Mississippi." His work, published in 1856, contains a mass of interesting detail, and it appears that he came to the conclusion that the Zodiacal Light was a ring of matter encompassing the Earth, and not the Sun; since he argued that the changes resulting from the observer's change of position on the Earth, as well as the alteration in position caused by the Earth's rotation, seemed to him much greater than could be explained if the ring were not relatively near the Earth. But surely to this it may be replied that no ring surrounding the Earth can in any way satisfactorily explain the phenomenon of the Zodiacal Light. But, assuming it were so, it is quite evident that, at a distance so moderate that a traveller in the tropical regions could recognise the change of position of the light as he passed from the north to the south side of the Equator, it would be invisible from places in high latitudes. In 1861 M. Chacornac observed the light in Paris and Lyons, and said that it was of sufficient power to obliterate stars of the twelfth and thirteenth magnitudes, and covers with a yellowish-red veil the region of the sky on which it is projected. The theory which connects it more immediately with the Sun has stood the test of more recent observations. The faint, yet exquisite, lustre has so far proved amenable to optical tests that the spectrum has revealed its identity with the solar radiance. The light is sunlight, and only differs from the latter in its intensity. It is due to reflection, and, whatever may be the nature of the material

which thus reflects the solar light, we may at once dismiss the idea that the Zodiacal Light is a mere extension of the Sun's atmosphere. There are dynamical reasons which render this idea untenable; and consequently we are driven to the conclusion that the phenomenon is caused by the presence of a multitude of small bodies, moving in orbits of their own around the Sun. In furtherance of this subject two points must be carefully borne in mind. The first is that there are phenomena of the light which indicate some resemblance, remote or otherwise, between its structure and that of comets' tails; so that not only meteoric matter, but also cometic matter, is probably present. The second is that it is highly improbable that the greater portion of the matter forming the light travels in orbits of small eccentricity around the Sun. Knowing that the orbits of meteors extend far into space, sometimes beyond the orbits of Uranus and Neptune, we must suppose that the meteoric and cometic matter of its light would travel in paths similarly eccentric, so that it will at times be far beyond the bounds of its visible extent. According to this theory the light should vary very markedly in appearance from time to time, and this, as a matter of fact, is precisely what has been observed, and remained unexplained until the eccentric nature of meteoric orbits was fully recognised. At the present moment the little bodies composing the light are believed to be something of the nature of Saturn's rings, the light, naturally, feebly reflected from the Sun, which renders it so indistinctly visible. This we learn from the researches made by the polariscope and the spectroscope. When we speak of "little bodies" in a cosmical sense, we are naturally compelled to enlarge our ideas with reference to magnitude. Sir John Herschel remarks: "Compared with planets visible in our most powerful telescopes, rocks and stony masses of great size and weight would be but as the impalpable dust which a sunbeam renders visible as a sheet of light when streaming through a narrow chink into a dark chamber." So it is with the Zodiacal Light. The Sun goes down below the horizon, but the rays shoot up into the mass of solid particles which revolves around it, and illuminate their surfaces, the aggregate effect to an observer on the Earth being that of a diffused sunbeam, taking the form into which the particles are grouped. Now this word "particle" must also be accepted in a magnified degree. Of course, it may happen that some of the constituent bodies are really small, and certainly none can be very large, otherwise they would not have escaped the careful scrutiny of the powerful modern apparatus. We may believe, then, that the total mass must be almost nothing as compared to that of the Sun. Hence the central luminary can suffer no perturbation from the vicinity of these revolving bodies, though collisions may occur among them, operating in the course of ages to effect a subsidence of at least some portion into the body of the Sun, or perhaps into certain of the planets.

An unpractised observer frequently fails to notice the Zodiacal Light, when it is not difficult to perceive it, because the very gradual diminution of its brightness, both upwards and laterally, deprives it of any definite outlines. We have the testimony of Schmidt, Jones, and other observers in support of the statement that it gradually fades away towards its edges. Jones especially calls attention to the variations in its brightness from time to time. Others have found it invisible, or at least very faint on some evenings, and it has been thought to be generally brighter in some years than in others. It is recorded that on January 31st, 1883, there were perceptible variations in its brightness relatively to the Milky Way. A distinction could be made between an inner and an outward zodiacal cone, mentioned by Jones as "the stronger and diffuse light." This might have been owing to the varying transparencies of the atmosphere through which the light is seen, or to varying sensitiveness of the observer's eye. With reference to the variation of brightness in different years, the evidence is not very conclusive. If one may venture to draw any inference from the various reports as a whole, it may be said slightly to favour the hypothesis of a variation in its brightness, coincident with the variation in the quantity of solar spots and of auroral displays, but the support at the best is not very strong. Among the few occasions when the light has been brighter than usual may be mentioned the month of March, 1843. That time was rendered remarkable by the sudden appearance of the great comet which caused then such a sensation. It so happened that the Zodiacal Light was noticed as brighter than usual; that Mr. J. Glaisher, writing from the Cambridge Observatory, made the singular mistake of confounding the two objects, saying: "The brilliant train which has for the last few nights attracted so much attention is doubtless only caused by the unusual brightness of the Zodiacal Light." The error was evident to all those observers who had seen the Zodiacal Light towering upwards from the horizon, having the Pleiades near its vertex, while the comet came sweeping downwards on the left. It is described as a magnificent spectacle not to be forgotten by any who witnessed it. It would seem as if the comet's presence were accompanied by some peculiar translucence of the atmosphere which rendered the Zodiacal Light more conspicuous.

There are also two phenomena which we may briefly notice in connection with this subject. One is the "Gegenschein," or "Counter Glow," and the other is the "Zodiacal Band." The "Gegenschein" is a faint patch of light seen very nearly opposite to the Sun's place. Professor Barnard has studied it for many years, and is of the opinion that it undergoes similar changes to the Zodiacal Light. He describes it generally as

a large and elongated patch of light, but not visible in June and December, when it crosses the Milky Way. Not very much is known as to its structure.

The "Zodiacal Band" is simply a prolongation of the light of the "Gegenschein." On some occasions it has been seen to stretch across the sky at midnight from the "Gegenschein," and connecting the evening and morning Zodiacal Lights. It is about thirty or forty degrees in width, and is best seen where it passes between the Pleiades and Hyades. But both the "Gegenschein" and the "Band" are extremely delicate phenomena, and require not only a clear sky, but a clear sight to glimpse them.

It would be presumptuous to say that the phenomenon of the Zodiacal Light has been fully solved. Yet, notwithstanding the apparent faintness of its luminosity, the real amount of light must be considerable. It must not be forgotten that this luminous cone is reared in that part of the sky which is bathed in the strongest twilight. Could it be seen amid a darkened sky, instead of being almost in the arms of day, its brightness would make it so conspicuous as to attract universal attention, especially as it differs in form from every other celestial object. Unlike the sunbeams, as they shoot upwards among the clouds during a gorgeous sunset, the Zodiacal Light is broadest at the horizon, and becomes narrower as it approaches the zenith. In the same way it differs from the fan-like rays of the Aurora Borealis. One thing, among the many, the heavens seem to tell with greater evidence from year to year is that space is not so void and empty as it was once thought to be; and that structures comparatively minute, as well as the immensely large, are widely spread among the framework of the universe.

SOLAR DISTURBANCES DURING APRIL, 1914

By FRANK C. DENNETT.

Every day during April it was possible to direct the telescope upon the Sun, and the month proved to be one of great interest. Only once—on the 15th—did the disc appear free from disturbance, and spots were visible on the remaining twenty-nine. At noon on April 1st the longitude of the central meridian was 123° 4′.

As No. 5 remained visible until April 12th, it reäppears on our present chart.

No. 6.—A little group of pores first seen on the 12th, a larger, followed at twenty thousand miles by two smaller ones. On the 13th the eastern pore was much the largest, the others being very insignificant, and on the 14th this pore, with a tiny companion, alone remained, but were not seen after.

No. 7.—On the 16th a solitary pore, seen double on the 17th, and by 18th a group of spots and pores forty-one thousand miles in length. It was usually seen after as two spotlets, with a few pores, varying in number and position, until the 25th, when the spots were almost lost among the faculae.

No. 8.—A little group of protean form, seen from the 19th until the 21st. Its length was thirty-five thousand miles, but its changes of four could only be shown by a series of diagrams. The components appeared increasing when last seen.

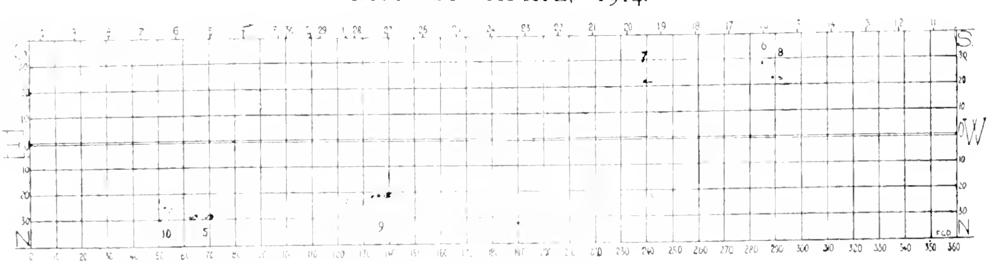
No. 9.—A group of pores when first seen on the 26th, three of which were a little larger than the rest. By the evening these three had become sensibly larger. Next day the leader had increased to sixteen thousand miles in diameter, and another seven thousand five hundred miles. On the 29th the great leader was twenty-two thousand miles across, with penumbral extensions making it quite twenty-six thousand miles, the group being over seventy thousand miles in length. A bright inrush of photospheric matter from the eastern side was noticeable on May 1st to 3rd, when last seen.

No. 8.—On the 27th an enormous faculic area, 20° from north to south, was seen coming round the north-eastern limb, evidently marking the place of No. 5. Amidst this a spot and some pores were visible on the next day, and which dwindled until last seen on the 3rd.

Faculae were seen on the 6th and 7th around longitude 126°, N. latitude 24°. On the 24th and 25th faculic areas showed around longitude 43°, N. latitude 22°, and longitude 108°, N. latitude 17°. Also near the north-eastern limb on the 9th, 19th, 22nd, and 27th. Also north-west on the 16th. Faculae were visible in the south polar region, April 18th and 20th, and south-east on each day from 19th to 23rd inclusive.

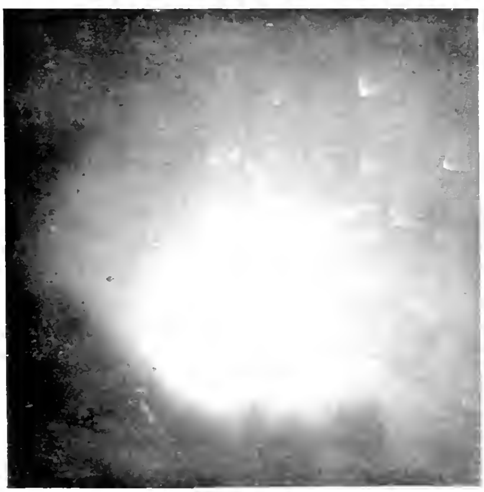
Our chart is constructed from the combined observations of Messrs. J. McHaig, A. A. Buss, E. E. Peacock, J. C. Simpson, and the writer.

DAY OF APRIL, 1914.



[illegible]

[illegible]



[illegible]

[illegible]

FIGURE 191. The Sch[illegible] Model Gyroscope Ship, shown [illegible] the mechanism for stabilisation exposed to view.

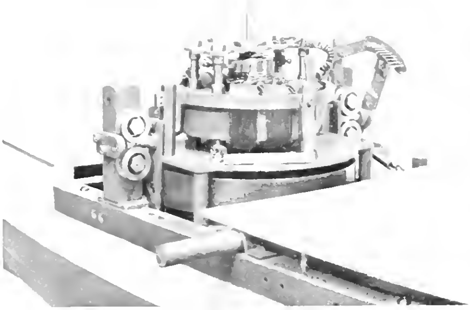


FIGURE 192. [illegible] Gyroscopic Mechanism [illegible] model ship.

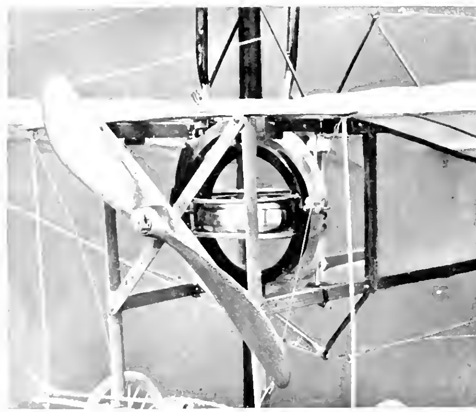


FIGURE 193. Enlarged view of the Gyroscopic Mechanism of the aeroplane.

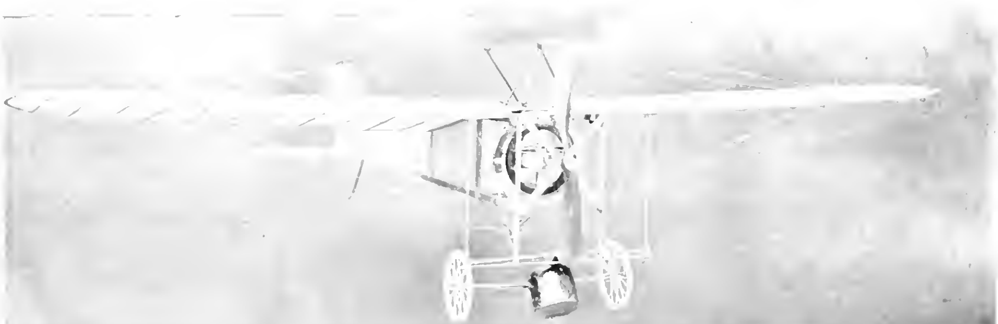


FIGURE 194. The Sch[illegible] Model Gyroscope applied to an aeroplane. The model is suspended [illegible] to allow it to oscillate freely in order to test the steadying effect of the gyroscope when in motion.

THE SCHILOWSKY GYROSCOPE APPLIED TO SHIPS AND AËROPLANES.

By J. HARRIS STONE, M.A., F.L.S., F.C.S.

In the April issue of this journal appeared an account of the mono-rail Schilowsky Gyroscope System as applied to trains and motor-cars—in other words, to earth-running vehicles—and it was there shown how important were the advances already made, and the practical applications which might be expected to flow from further developments of the marvellous invention. Our prognostication has proved to be neither incorrect nor too sanguine. The Russian scientific man has not been idle. During the last few weeks he has deposited in the South Kensington Science Museum, as presents to the nation, his first completed working models of the gyroscopic invention as applied to the stabilisation of ships and of aëroplanes. These two new models with the working mono-rail train already there, and which we described in the April issue, makes the South Kensington Science Museum the richest in practical gyroscope appliances in the world—the gyroscope as applied to the stabilisation of vehicles on earth, water, and in the air. The thanks of the nation are therefore due to M. Schilowsky for his generosity in thus enabling those interested in the subject to see for themselves, and to test the wonderful contrivances which will for ever be associated with his name.

The difficulties to be encountered in stabilising an earth-running vehicle on two wheels are, from a scientific point of view, greater than those to be overcome in an aquatic or aërial conveyance. A ship and also an aërial machine have already a certain amount of inherent stability, owing to the media in which they progress; and their line of support, of equilibrium, being above the centre of gravity, theoretically, it were easier to impart a still greater amount of stabilisation to such craft than to a motor-car or train. But, practically, the difficulties are still great, and it may be long yet before a ship is constructed which is rigid in all directions except that of direct progression, or an aëroplane made which will always rapidly and automatically right itself when upset by blasts of powerful winds or other causes. Now in a ship, if the movement (other, of course, than that of progression) were confined strictly to what is known as pitching—an upward and downward vibration only—sea-sickness and discomfort would, if not nearly obliterated, be rendered much less prevalent. It is when the pitching of a vessel is combined with the horrid rolling motion that the nausea reaches its zenith, and life to so many of us becomes almost unsupportable. The Schilowsky gyroscope, as applied to ships, is an attempt to minimise, reduce, or even to obliterate the rolling. As a ship afloat is a stable but an oscillatory body, the gyroscope is fitted in a stable manner.

As is shown clearly in Figure 191, the gyroscope is pivoted to the model ship by a system of sliding pivots affixed to it above its centre of gravity. If the ship is leaning to either side the gyroscope slides a little along its pivots to the inclined side (port or starboard, as the case may be), and at the same time a suitable arm engages a ratchet device, elastically pivoted to the frame, and this contrivance retards the swinging movement of the gyroscope. M. Schilowsky is the first practical experimenter with gyroscopes to demonstrate that in gyroscopes suspended above the centre of gravity, used for stabilising stable but oscillatory bodies, it is necessary to bring the troubled gyroscope and the vehicle to their normal positions, and that these results can only be effected by forces just opposite in action to those used for unstable bodies. In place of hurrying up the precision mechanism, a retarding precision device is employed which the inventor calls "anti-precessional." In the model ship at South Kensington it is clearly seen that since the retarding mechanism is put into operation in the vessel, to which an oscillatory motion is given, it restores the horizontal equilibrium of the vessel. Once restored, the gyroscope slides back, and disengagement occurs, leaving the gyroscope ready to repeat the equalising operation. It is in this device that the peculiar invention of M. Schilowsky is evident.

As in dealing with a ship, we have, as already mentioned, not to stabilise a very unsteady body, like a motor-car or a train: the gyroscope for a ship can be of comparatively trifling weight, and can revolve with comparative slowness. M. Schilowsky is of opinion, he tells me, that the weight of the ship gyroscope could be decreased to about one-half per cent. of the total weight of the ship; but I fancy it is extremely difficult, at the present stage of the science, to accept this as an infallible datum. I tried the ship model experimentally, and found that it rocked from side to side—port to starboard—just fourteen times before finding rest: that was when set into rocking motion with the gyroscope not in action. When the gyroscope was revolving, but without the side-ratchet contrivance being in gear, the vessel rocked just one half, or seven times. When the gyroscope was revolving, and the side-ratchet apparatus used for exercising the controlling influence on the instrument (in the model on the starboard side of the ship) brought into play the rocking movement was *at once* arrested. So

quickly was this effected that it seemed little short of marvellous. It is as if some overruling, sentient power were dominant in the ship, which instantly, when rolling began, said, "No, you shall not roll!" This was apparent when the speed of the gyroscope was decreased to quite a trifling number of revolutions—only about five hundred a minute. With that speed the retarding device stabilised the model ship, though not with the same resistive strength as when it was running at two thousand revolutions.

From this description it will be apparent that there are attached to the gyroscope, as applied to ships, no heavy or large pendula as are used in the instruments for stabilising land vehicles, for the weight of the gyroscope itself takes the place of those heavy swinging adjuncts attached to the land instrument.

There is a very prevalent opinion that aëroplanes are very unstable—more so than any other vehicle—but this is hardly correct. In reality, an aëroplane is, like a bird, comparatively speaking, stable, but very oscillatory, and loses very easily its stability when a rolling motion is accelerated. It is therefore most important for the safety of those travelling aërially that the rolling motion should be stayed, and an attempt to attain this object is made by the Schilowsky gyroscope. Were the rolling propensity obliterated, the brains and strenuous attention of the pilot in the aëroplane (which are now largely engaged in overcoming the oscillations of his machine) could be directed solely to overcoming the longitudinal—the up-and-down—movements. In the aëroplane model (a beautiful and exact to scale monoplane of Blériot's) at the South Kensington Science Museum the weight of the pilot is represented by a heavy iron weight, and the gyroscope is proportionately not the weight of a single passenger. When the gyroscope was in action in the model I found it difficult to divert it from the horizontal position, even when pressing with some force on the extreme tip of a wing. Its stiffness was remarkable. The action of the gyroscope as applied to the aëroplane is similar to that used for vessels. Each rolling swings over the gyroscope, sliding on pivots, to the inclined side, and during this movement it comes into contact with the retarding spring, and, consequently, the anti-precessional mechanism is brought at once into play, with the result that the aëroplane is restored to its correct plane of flight. In full-sized aëroplanes the same petrol engine which drives the fan would also cause the gyroscope to revolve, and the alighting of such a fitted aëroplane on earth or water would therefore also be a matter of ease and great delicacy. Altogether, it is not unlikely that in the next few years we shall witness many marvellous, almost revolutionary, improvements in aëroplanes, especially as regards their safety and carrying capacity, some of which, at an rate, will be due to the use of the gyroscope—an instrument which has only just emerged from the status of a nursery toy.

It may be added that the two-wheel (mono-track) motor-car—figured and described in the April issue—fitted with M. Schilowsky's gyroscope, has been making many runs about London during the last week or two, to the great delight and wonderment of the public.

EARTHQUAKES IN NORTH AMERICA.

The Rev. Father Tondorf, S.J., Director of the Georgetown Seismic Observatory, has contributed the following interesting note to *The Georgetown College Journal*.*

"The series of lesser shocks, recently experienced over that area of North America resting upon rock of the Laurentian period, has emphasized the fact that this region is by no means immune from appreciable seismic disturbances. Of timely interest, therefore, in this connection may be found the following account of a far more violent, wide-reaching and long-lasting disturbance of the same region, recorded in the year 1663 by the Jesuit missionary, Père Charles Simon. His original account in French was rendered into Latin by his friend, Père François Ragueneau. It is from this Latin version, which is in our archives, that the account is taken. Many incidental and picturesque details not of scientific value have been omitted, nor has any attempt been made to alter in any way the quaint phraseology of the eye-witness of this direful cataclysm."

The first part of the above-mentioned account we reprint below.

"February the 5th, 1663, chronicled as the day of the earthquake, broke tranquilly with sky serene. At five o'clock in the evening a sound was heard seemingly centred at a distance. A frightful crash followed, appearing to come from the lowest depths and the extreme confines of the earth, resembling in sound the battle of the waves and the roar of the sea. Thereupon followed a shower of stones, which shattered the roofs of the houses and burst into barns, chambers and the most hidden nooks. Finally the dust rose in whirling columns and formed into clouds. Doors suddenly opened and closed themselves; church bells rang out in token of the general alarm; steeples of churches, like tall trees, became the sport of winds, swayed in every direction; walls were broken, stones dislodged and timbers gave way; men rushed out of their houses while others sought refuge in houses. Thunder reverberated and lightning flashed in the heavens. The earth rolled to and fro under foot as a boat is restlessly buffeted about by the waves. The violence of the first shock subsided after about half an hour. Towards nine o'clock in the evening the earth again began to shake, and that alternation of shocks lasted until the ninth of September. During this period there was a great variety of dissimilar shocks. Some were longer, others shorter; some were frequent but moderate; others, after a long intermission, were more violent. These occurrences seemed to be more frequent by night than by day. Here and there, wide gaps appeared in the earth and frequent fissures. New torrents swept their way and new springs of very limpid water gushed forth in full streams. On level ground, new hills have arisen; mountains, on the other hand, have been depressed and flattened."

* March, 1911.

THE PHYSICAL CONDITIONS OF THE JEWISH RACE.

By ISRAEL COHEN, B.A.

The Jew has many distinguishing characteristics both of an anthropological and a physiological nature. Their origin is to be sought partly in the racial stock to which he belongs, partly in the endless vicissitudes through which he has passed, partly in the environment in which he has dwelt, and partly in the mode of life that he has followed. His anthropological characteristics are due to the racial factor, and they owe their preservation in approximately their original condition to the social isolation in which he has for the most part lived since the days of his dispersion. His physiological characteristics are due in greatest measure to the hygienic laws which he has observed as part of his religion, and likewise to the sufferings which his people has endured in its struggle for existence, and the effects of which, both beneficial and detrimental, he has inherited as a national legacy. The characteristics of both kinds will be found in their fullest extent among the Jews who live in compact settlements, particularly in Eastern Europe, and in the Western communities composed of those who have themselves migrated from the East. The anthropological traits have a longer and stronger persistence than those of a purely physiological order: they are rooted in the blood, and will even reässert themselves in the grandchildren of those who have married outside the Jewish pale and withdrawn from the Jewish community. The peculiarities of a physiological nature are dependent upon more governable factors, and they become weaker or disappear in proportion as the individual Jew abandons the habits and customs of centuries and adopts the mode of life of his non-Jewish neighbours.

The distinctive features of the Jewish type consist of dark hair and eyes, and hence, owing to the preponderance of this feature, the Jews belong to the brunette group of the human race, or, more particularly, to the brunette group (Melanochroes) of the white race. The blond type, consisting of fair hair and blue eyes, and the mixed type, consisting of fair hair with dark eyes or dark hair with light eyes, are also found in small and varying proportions in different countries. The prevalence of this blond type has been explained by some anthropologists as the result of intermixture with the native populations, but this view is contradicted by the presence of fair-haired Jews in the north of Africa and in Syria, which are not inhabited by blond peoples, as well as by the presence of blond types among the Samaritan Jews, who have scrupulously safeguarded their racial purity. The causes of these diverse types among Jews must not be sought in their kinship or supposed intermixture with alien races, but in the forces of nature that originally determined the genesis of these respective types among other groups of the human race. The differentiation of pigmentation, as Dr. Zollschan has shown,* is the effect of varied climatic and geographical conditions: it is a protective measure of Nature against the injurious chemical and calorific effects of the fierce rays of the sun. The other main characteristic of the Jewish type is short-headedness (brachycephaly), the cephalic index of the majority of Jews being estimated by Dr. Judt as ranging from 80 to 83·6.† There are, however, many representatives of the long-headed, or dolichocephalic, type, as in Arabia, Morocco, and Algeria. This diversity of head-form is advanced by Dr. Fishberg ‡ as his principal reason for disputing the racial purity of the Jews, as he maintains that changes in the form of the head can be produced only by racial intermixture. But Professor Franz Boas,§ who has taken measurements of thirty thousand immigrants and descendants in New York, has shown that the change of environment from Europe to America has a potent influence upon such racial traits as stature, head-form, and complexion. East European Jews with brachycephalic heads become long-headed, and also increase in stature and weight. A similar phenomenon may also be observed among the immigrants and their descendants in London. Moreover, Nyström || has shown that the shape of

* Dr. Ignaz Zollschan, "Das Rassenproblem" (Vienna, third edition, 1912), page 123.

† "Jüdische Statistik" (Berlin, 1903), page 421.

‡ Dr. M. Fishberg, "The Jews: a Study of Race and Environment" (London, 1911).

§ "Changes in Bodily Form of Descendants of Immigrants" (Washington, 1910).

|| Dr. Ignaz Zollschan, "Das Rassenproblem," page 90.

the skull can be differently influenced by the pose of the body involved by one's daily occupation and mode of life, and that the increased pressure of brain and blood caused by intense intellectual activity tends to produce brachycephaly. Thus changes of head-form afford no proof of racial intermixture. It had long been supposed that the hook-nose is also a salient, if not the most distinctive, feature of the Jewish type, but careful observation among the Jews of Russia and Galicia has shown that from sixty to eighty per cent. possess straight or "Greek" noses. The Jewish hook-nose thrives only in the comic papers. That which constitutes the peculiarity of the Jewish nose is, not its shape or profile, but, as Joseph Jacobs was the first to point out, "the accentuation and flexibility of the nostrils," a view with which Ripley agrees.*

The predominance of the brachycephalic type among the Jews has led to a revision of the traditional view as regards their Semitic origin, since the peoples of the so-called Semitic stock were dolichocephalic. Even Jewish writers who are in favour of Jewish nationalist aspirations, such as Dr. Zollschan and Dr. Judt, have discarded the conventional theory of the origin of their people. Dr. Zollschan has pointed out that it is absurd to speak of the Semitic race at all, as this term, like the collateral expression, "Aryan," simply applies to a family group of languages, but affords no indication of the racial kinship of those among whom they are spoken. According to Zollschan the Jews at the time of their entry upon the arena of history were the product of an amalgamation of the peoples of North Africa with those of South-western Asia, and they were particularly influenced by the Assyrian and Babylonian elements among the latter as regards their complexion. Judt, on the other hand, believes that the Hittites formed the physical nucleus of the Jews, who owe to them their distinctive physiognomical traits, whilst according to Professor von Luschan the three principal elements in the composition of the Jewish type were the Semites, the Aryan Amorites, and the Hittites. But although it is impossible to establish with exactitude the genesis of the Jewish type, since anthropological science still provides a field of heated conflict, it is sufficient to know that, according to unbiassed authorities, the racial amalgamation of which the Jews are the product took place some four thousand years ago, and that the Jewish type has been preserved intact to the present day.

The evidence of history strongly supports the view that the Jewish race did not suffer any appreciable influx of alien blood in Europe. The Jewish community in almost every town was both locally and socially segregated from the rest of the population. There was a widespread feeling of hostility between Jews and Gentiles throughout the Middle Ages, which afforded little encouragement to mixed marriages, and both Synagogue and Church strictly forbade such unions. Moreover, the Rabbis discouraged proselytism, and the records of conversion show that the Jewish community lost far more in deserters than it gained in proselytes. The only notable exception consisted of the Chazars, a people of Turkish origin, who formed an independent kingdom in the south of Russia from the seventh to the eleventh century, and whose ruling classes embraced Judaism in 620.† But the descendants of these Jewish converts were subsequently absorbed among the Karaites, who do not intermarry with orthodox Jews, and thus they cannot form an argument against the purity of the Jewish race. In any case the amount of the intermarriage with Jews is not known to have been great, and its physical effects must have been eliminated in the course of a few generations, as small admixtures from an alien stock leave no anthropological trace behind them. Mixed marriages, so far as has been ascertained, are less fertile than purely Jewish marriages, owing either to racial incongruity or to the characteristics of the social stratum in which they mostly take place, and all but a tenth of the offspring of such unions go over to Christianity.‡ It may therefore be safely concluded that the Jews are comparatively free from any strain of alien blood derived from the nations of Europe, whatever admixture they may have themselves contributed to these nations. Beyond the zone of the Western world, however, there are indeed three historic cases of alien intermixture with Jewish blood: the Jews of Abyssinia, known as Falashas, who claim descent from the retinue of Menelik, the son of King Solomon and the Queen of Sheba, and who present a negroid type; the Black Jews of India; and the small and dwindling colony of Chinese Jews at Kai-Fung-Foo. But these abnormal types are comparatively few in number, and, owing to their remoteness and isolation, they cannot be considered as affecting the purity of the general body of the Jewish race.

If we desire a concrete and impartial testimony that the Jewish type has not undergone any appreciable alteration in Europe during the last two thousand years, we shall find it in the imposing monuments that have been brought to light from the buried cities of Babylonia. The bas-reliefs of Hebrew prisoners taken by Shishak in 973 B.C.E., and of the inhabitants of Lachish, who submitted to Sennacherib in 701 B.C.E., present a striking

* Article "Nose" in "Jewish Encyclopaedia," IX.

† According to A. Harkavy, "Meassef Niddahim," I. Other authorities give 740 as the date of conversion.

‡ W. Z. Ripley, in "The Races of Europe" (New York, 1899), has published photographs showing the similarity between Jewish types of Russia, Caucasus, Arabia, Syria, Tunis, Bochara, and India.

resemblance to the predominant Jewish type of the present day. The preservation of this type from so remote a period is due primarily to racial evolution and successive centuries of in-breeding, but it is not less due to common national experiences, which have endowed it with specific qualities of a physical and moral order. Behind the walls of the Ghetto the Jewish type was carefully protected from the influence of its alien environment, and there it also received a special impress, the product of exile and oppression. The chronic outbreaks of massacre and banishment, the unceasing reign of petty despotism, economic misery, and nervous alarm, have wrought traces upon the organism of the Jew: they have bent and stunted his body, while they have sharpened his mind and brightened his eye; they have given him a narrow chest, feeble muscles, and pale complexion; they have stamped his visage with a look of pensive sadness, as though ever brooding on the wrongs of ages. But the frame that has endured and survived so much suffering is also endowed with a high degree of resistance.

In the remotest regions there may be found Jews of a similar type, as in Aden and Galicia, in Egypt and Persia, in Samarcand and Palestine; and yet we cannot assert that there is a single uniform type at the present day. A few hours' careful observation among the Jewish inhabitants of a Western city, or even a few moments' scrutiny among the delegates of a Zionist Congress, would soon reveal the existence of varied types. The cause of this variation is not far to seek: it consists in the influence of local environment, which forces upon the Jewish physiognomy some of the traits of the predominant type, a process favoured in Western countries by the increase of social intercourse with non-Jews as well as by the preference of the non-Jewish type for marriage both by Jew and Jewess. Thus it is that several eminent Jews of the last fifty years have had little similarity to the average racial type: Cesare Lombrose in Italy, Sir Julian Goldsmid in England, George Brandes in Denmark, Baron Maurice de Hirsch in France, have all shown a marked resemblance to the characteristic type of their native country, whilst Dr. Theodor Herzl, on the other hand, recalled the majestic presence of an Assyrian emperor. But although these types show a divergence from what is popularly called the Jewish type, there is no ground for denying the existence of the latter, as is done by some writers, since the majority of Jews present—to use a mathematical term—the highest common factor of physical and physiognomical characteristics distinguishing them from non-Jews. The truest statement of the position would be that there is a variety of Jewish types, each possessing an unmistakable Jewish factor, and yet presenting a certain resemblance to the predominant local types, which results from the unconscious mimicry of muscular movements. This difference has been characterised as a difference in the social types of Jewry, which helps us to read in the face of each Jew the land of his origin, whether he is a native of Russia, Germany, England, or America. That which is popularly known as the Jewish expression is found mostly among those who live in or originate from Eastern communities, and it has even been observed to develop at a later age in the case of some who have not had it in their youth, but on the whole it diminishes among those who have constant intercourse with non-Jews, and who live beyond the influence of a Jewish atmosphere.

The physiological characteristics of the Jew are not due to any organic peculiarities of a racial origin, but to social, historic, and economic causes. Having dwelt for nearly two thousand years in towns, and for the greater period in the most insalubrious and congested quarters, and having been compelled to endure all manner of persecution in his struggle for existence, he possesses a constitution that combines a poor muscular development with a highly developed nervous system. His average height in Eastern Europe is five feet three or four inches, whilst that of the Jewish immigrants in the United States is five foot five inches;* but the native Jews, both of New York and London, are taller than their foreign parents, and thus demonstrate how susceptible is the physique of the Jew to the influence of environment. The inferiority of the Eastern Jew in chest-development is still more striking. Among healthy and normally developed people the girth of the chest equals or even exceeds half the stature; but this proportion is far from common among the Jewish masses of Russia, who present a larger percentage of military recruits with deficient chest-measurement than any other subject people of the Tsar.

Investigations spread over twelve years (1886–1897) have shown that among every thousand Jewish conscripts there were 491 whose chest-measurement was less than half their height, while among a thousand Christian conscripts there were only 128.† Dr. Max Mandelstamm, of Kiev, who had exceptional facilities for studying the physical conditions of the Jews in the Russian Pale, cites without reservation the testimony of military physicians, that sixty per cent. of the Jewish recruits have a deficient chest-circumference.‡ The Russian military authorities have accordingly lowered the standard of their requirements for Jewish subjects.

Despite his pallid face and feeble frame, the Jew displays a remarkable strength in resisting disease. Cooped up in the poorest, the most crowded and

* "The Immigrant Jew in America" (New York, 1907), page 282. † "Jüdische Statistik," page 306.

‡ "Report of Physical Condition of the Jews" Fourth Zionist Congress, London, 1900.

insanitary districts of great cities, where the air is foul and the light is bad, he succeeds in living to a great and even venerable age. Denied the boon of invigorating his stock with the blood of a country-bred element—an advantage open to all other nations—he nevertheless succeeds in perpetuating his line to a fourth and fifth generation. The secret of his health and longevity lies wholly in his mode of life, which is prescribed and fashioned by law and custom. But some of his immunity from certain diseases may rightly be referred to heredity, for a stock that has survived the perils and persecutions of many ages must have inevitably become stiffened in the process. The most tangible grounds of the good health of the Jew, however, consist in the dietary and hygienic laws which he observes as faithfully as the Ten Commandments, in his notable sobriety, in the weekly Sabbath rest, and in the quietude and purity of his family life. The legislation of the Bible and the Talmud was directed to secure the physical as well as the spiritual welfare of mankind, and all the religious codes accepted by orthodox Jewry preserve and emphasise this principle. The prohibition of certain beasts, birds, and fish as unclean for food, the careful examination of animals after slaughter, to see that they are free from any disease of the lungs or pleura, and the draining of the blood from meat before cooking, combine to protect the body from elements that might be injurious, and diminish the liability to contract such maladies as bovine tuberculosis, trichiniasis, and typhoid fever. The cleanliness of the person is secured by a strict insistence upon the use of baths and ablutions as almost a religious duty. The hands and face must be washed in the morning before any food is touched; the hands must always be washed after relieving Nature and after touching any part of the body that is usually covered, and they must likewise be washed before every meal. The Jew, moreover, laves his hands again after the meal, before uttering grace. A bath is prescribed before Sabbaths and festivals, and the *Mikvah*, or ritual bath (which must contain at least one hundred and twenty gallons of water), must be visited by every woman at least once a month.* The ritual observance of these practices is slowly falling into desuetude in Western countries, but it is faithfully upheld in Eastern communities. The cleanliness of the home is secured by the scrubbing and cleaning of the living-rooms on the eve of every Sabbath and festival, and by the thorough scouring and scraping of every nook and cranny in the house—walls, woodwork, floors, furniture—on the eve of Passover, the latter process being more thorough, if anything, than the usual English spring-cleaning.

The salutary effect of these dietary and hygienic regulations is supplemented by moderation in alcoholic indulgence; for although the Jew drinks wine for the ceremonial of sanctification on Sabbaths and feasts, and takes spirits on all festive occasions, he knows how to set a discreet limit to his appetite. There are no Temperance leagues in Jewry, and yet in no other community is the number of drunkards, or of those suffering from alcoholic excess, so small in proportion. The perfect repose, both of body and mind, secured by the Sabbath and by the more important festivals, which amount to thirteen days in the year, affords an excellent means of recuperation from toil and worry, for these religious celebrations are free from those drinking bouts which desecrate what should be the solemn days of other communities. And a further series of important factors consist in the early age of marriage, the sanctity of the family tie, and the devotion which parents lavish upon the upbringing of children. Finally, the whole philosophy of the Jew is coloured by the view that life is a very precious thing, and that everything may be sacrificed to its preservation. The guiding principle of the Rabbis, based upon the dictum of the Pentateuch (Lev. xviii, 5), was that the laws and statutes of the Bible were given so that man might live by them and not die through them.† Hence they declared that in case of danger to life one might commit any transgression except idolatry, murder, and adultery;‡ and the relaxation they allowed had special application to the Sabbath, on which the doctor might heal the sick, though all other work was forbidden.

In the light of this hygienic dispensation it is not surprising that the Jews everywhere have a lower rate of mortality than the people among whom they live, even though they generally dwell in the most crowded and insanitary districts. In no country that has been investigated does their annual mortality exceed 20 per 1000. Between 1876 and 1910 their mortality in Prussia, Bavaria, and the Grand Duchy of Hesse declined from 17·8 to 13·8 per 1000, and in 1911 their mortality in Prussia was 11·1, whilst that of the Christian population was 17·1.§ In Hungary their death-rate in 1911 was 15·3, as compared with 25·1 per 1000 of the general population; and in Vienna, in 1908, it was only 12·1, contrasting with a mortality of 18·1 per 1000 of the general population.¶ They enjoy the same

* In Germany, of one thousand four hundred Jewish communities, seven hundred and seventy-two have a *Mikvah*. In Russia there is hardly a single community without one ("Zeitschrift für Demographie und Statistik der Juden," 1912, page 87).

† Talmud, *Yoma*, 85b. ‡ *Pesachim*, 25a.

§ "Zeitschrift für Demographie und Statistik der Juden," 1913, January and September.

Ibid., page 118. ¶ *Ibid.*, 1911, page 118.

advantage in Eastern Europe, too. Thus, in 1903, in Russia, they had a mortality of only 11·5, whilst that of the Orthodox Russians was 32·2, and that of the Mahommedans 24·3 per 1000; and in Poland they had a death-rate of 15·8, whilst that of the Catholics was 23·4.* Similarly, the average death-rate of the Jews in Bulgaria declined between 1891–95 and 1901–04 from 23·40 to 15·49 per 1000, whilst that of the general population only declined from 27·80 to 22·63;† and in Roumania the Jewish death-rate between 1907 and 1910 declined from 18·94 to 16·85, whilst that of the general population only declined from 26·1 to 25·38.‡ The same phenomenon has been corroborated among the Jews in London, Manchester, and New York. In Whitechapel, according to Dr. J. Loane, who gave evidence before the Royal Commission on Alien Immigration in 1902, the death rate of the district, in the period 1880–1900, when the Jews settled there in large numbers, declined from 26 to 18 per 1000, and the foreigners have a death-rate of 15·6, as against the native rate of 20;§ in Manchester, during the years 1900–02, the death-rate for the entire city was 21·78, whilst in the Jewish district of Cheetham it was only 16·99;‖ and in New York, during the six years ended May 31st, 1890, the Jews had a mortality of only 11·85 per 1000, which was lower than that of any other race in the city.¶

The favourable position of the Jews in regard to mortality in general is exemplified very strikingly by the rate of infantile mortality, which everywhere forms a good proportion of the general mortality. Thus, according to the evidence given before the Royal Commission on Alien Immigration, the infant mortality increased in London in the period 1886–1900 from 153 to 161 per 1000 births, whilst the Whitechapel district showed a decline from 170 to 144; and in Manchester, in 1898–1901, the infant death-rate was lowest in Cheetham, the figures in 1899 being 104 for this Jewish district and 205 for the whole city.** Similarly, investigations have proved that those districts which are mostly inhabited by Jews in New York, Philadelphia, Chicago, and Boston, although the most overcrowded and insanitary, have the lowest rate of child mortality.†† In the Grand Duchy of Hesse the average rate of infant mortality in 1906–10 was 129 per 1000 of the Christian population, but among the Jews it was only 72;‡‡ and in Hungary, in 1910, the mortality of Jewish children under seven years of age formed 35·8 per cent. of all Jewish deaths, whilst among the Protestants it was 42·1, and among the Catholics 49·7 per cent.§§ Moreover, in Russia, according to the census of 1897, the infant mortality was 150 per 1000 births among the Jews, whilst it was 154·2 among the Catholics and 274·3 among the Greek Orthodox;‖‖ and in Cracow, which is typical of Galicia, the corresponding average rate for 1891–96 was 155 for the Jews, but 171 for the Christians.¶¶

The low death-rate of Jewish children is due to the scrupulous care of the mothers in rearing their offspring. Throughout Eastern Europe Jewesses, after marriage, very rarely work in factories or at home; they invariably nurse their children at the breast; and in all parts of the world they are known to display an excessive solicitude about the health of their children, and to seek the best medical advice upon the least suspicion that anything is wrong. The low rate of the general mortality must also be attributed partly, in addition to the factors previously mentioned, to the nature of the occupations in which Jews engage. The large majority, particularly in Eastern Europe, are merchants or small traders, or engage in indoor occupations, and thus belong to the long-lived class. Their avoidance of dangerous trades, such as mining, building, and railway employment, is due, not to any deliberate precaution, but, for the most part, to the fact that such occupations would involve, more seriously than others, regular isolation from the Jewish community and violation of the Sabbath. We are thus led to the conclusion that the low mortality of Jewry is due in the main to its specific social, hygienic, and economic conditions, a view that is supported by the fact that the death-rate of the Jews is smallest where they live apart, whilst it increases where they freely intermingle with their non-Jewish neighbours.*** But, apart from all these considerations, it is only natural that the Jews, who have waged such a long and stubborn fight against the forces of destiny, should have acquired a certain ingenuity in the art of defeating Death.

(To be continued.)

* "Zeitschrift für Demographie und Statistik der Juden," 1913, January and September, pages 39-41.

† *Ibid.*, page 17. ‡ *Ibid.*, 1912, page 16.

§ "Minutes of Evidence" (1903), 4538-4555. ‖ *Ibid.*, page 799.

¶ J. S. Billings, "Vital Statistics of the Jews in the United States" (1890).

** "Minutes of Evidence," 3960, 21742-46. †† "The Immigrant Jew in America."

‡‡ "Zeitschrift für Demographie und Statistik der Juden," 1913, page 7. §§ *Ibid.*, 1912, page 78.

‖‖ "Die sozialen Verhältnisse der Juden in Russland," page 29. ¶¶ "Die Juden in Oesterreich," page 33.

*** Among American Jews the death-rate of the native-born is 9·46 per cent., but that of the foreign-born 7·61 per cent. ("Jewish Encyclopaedia," Volume IX, article "Mortality").

VARIABLE STARS.

By JOHN L. HAUGHTON, M.Sc.

Introduction.

ALTHOUGH the subject of stellar variability is one of extreme fascination, people who demand an answer to every why and wherefore connected with the subject that they are studying, will derive but little satisfaction from a review of our present knowledge of the causes underlying the strange phenomena detailed in this paper. At present most of it can be summed up in the words of Tennyson:—

> "A mystic star
> Between the less and greater glory varying to and fro,
> We know not wherefore."

And yet the knowledge that has been attained of the *modus operandi* of at least one class of variables encourages us to hope that some day all will be explicable.

The subject is so tremendous that it is impossible to do it justice in a short paper like the present one, while its very nature makes any account tend to degenerate at times into a rather too catalogue-like list of marvels. Nevertheless, the subject is of such interest and importance that the following brief summary should be of some value.

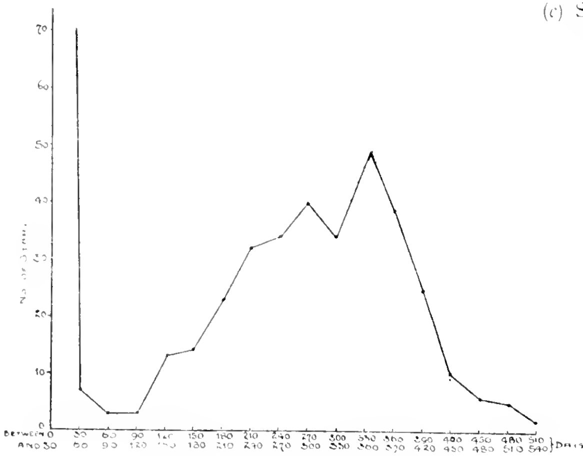


FIGURE 195. Distribution of Periods of Variable Stars.

Classification.

Variable stars may be arranged into two classes: those which go through their light changes in a regular manner, and those whose period or range is irregular. For purposes of convenience, however, a much fuller system of classification was drawn up by Pickering; slightly modified, it is as follows:—

(*a*) Temporary or new stars.
(*b*) Long-period variables (including stars with very irregular periods).
(*c*) Short-period variables.
  1. Eclipsing stars (or Algol variables).
  2. Non-eclipsing stars.
    (i) Geminid variables.
    (ii) δ Cepheid variables.
    (iii) Cluster variables.

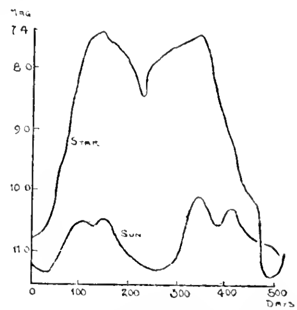


FIGURE 196. Light-curve of R Normae and curve of area of faculae on the Sun.

At first sight the distinction between "long" and "short" periods may appear to be an arbitrary one, but a glance at Figure 195 will show that there seems to be a real basis for this division. Of four hundred and fourteen variables fifty-two have periods of less than ten days, eight between thirty and sixty days, three between sixty and ninety days, while forty-nine vary between three hundred and thirty days and three hundred and sixty days. Thus stars with a period of over one hundred days may be reckoned as long- and those with less than this as short-period variables. Furthermore, it is found that the latter are, as a rule, brighter than the long-period variable stars, and tend to congregate in the Milky Way.

It will be noticed that this classification does not include temporary stars in the same group as long-period variables, for there is abundant evidence to show that they are in many ways quite different from these latter.

New Stars.

Between the years 134 B.C. and A.D. 1903 twenty-seven new stars have been observed, and several curious facts as to their distribution have come to light. In the first place, with only one exception,

they have appeared in the Milky Way, nine of them being in the adjoining constellations of Scorpio and Ophiuchus, an area covering about thirty or forty square degrees in the sky. Again, they seem to have come in batches separated by very long intervals. For example, three appeared in the seven years following A.D. 386, and for the next four and a half centuries none were observed.

A few facts concerning the most interesting of these remarkable objects will not be out of place here.

The most brilliant Nova of which we have a record of accurate observations was that which appeared in November, 1572, and was observed by Tycho Brahé. It was bright enough to be visible at midday to persons possessing good eyesight, and remained so for three weeks, after which it began to fade, and finally disappeared in March, 1574, that is, after sixteen months. Within one minute of arc of the position of this object as given by Tycho there is a small red star varying from the eleventh to the twelfth magnitude, and frequently appearing hazy and ill-defined in the telescope, and there appears to be no doubt that this is the once magnificent star of Tycho. *Sic transit gloria stellarum!*

A similar history was left by Kepler's star, which, in October, 1604, was brighter than Jupiter, and vanished seventeen months later. It, however, is not now visible in the telescope, or, rather, there is no star in the neighbourhood that can be certainly identified with it.

The Nova of 1866 is of special interest from two points of view. In the first place, it was the earliest temporary star which was examined spectroscopically; and, secondly, the very rapid increase in brightness was made manifest by one of those great strokes of luck that sometimes fall to astronomers. At 9 p.m. on the night of May 12th, 1866, Schmidt, of Athens, carefully surveyed the constellation of Corona Borealis, and noticed nothing unusual about it. He was certain that there was no star present as bright as the fifth magnitude, which was not there normally. Yet two and a half hours later John Birmingham, of Tuam, saw a second-magnitude star shining in that very constellation. Thus, in two and a half hours, a star rose from less than the fifth magnitude to the second, or, in other words, increased in brightness sixteen times. It is now a constant 9·5 magnitude star, and if we assume it to have been of this magnitude prior to the outburst, it must have increased in light-emitting power one thousand times.

Spectroscopically it was seen that T Coronae, as the star was called, gave a bright-line hydrogen spectrum superposed on a continuous one traversed by many dark flutings.

The spectrum changes of Nova Cygni, observed in 1876, were very remarkable. When first examined it yielded a solar spectrum with the Hydrogen, Helium, and Magnesium lines bright. The red C line of Hydrogen was the most prominent, but as the star faded, so did the C line, while a green one came to the front; later a blue one—suspected to be due to Nitrogen—took the lead. All this time the chief line in the green, which shows in the spectra of all gaseous nebulae, was becoming more and more visible until, by the time the object had dwindled down to the 10·5 magnitude, it was the only line which showed, and the star had assumed the appearance of a planetary nebula. Three years later it was of the twelfth magnitude, and the spectrum was stellar once more, and later still Professor Barnard, observing with the 40-inch Yerkes refractor, saw it as a 15·5 magnitude star having an ill-defined appearance.

Nova Aurigae and Nova Persei, both discovered by Dr. Anderson, showed all the spectral lines very much widened, and each bright line accompanied by a dark one. This has since been found to be the general characteristic of new stars. The spectrum of Nova Persei, when first observed, was continuous, probably due to its being discovered before the gaseous conflagration had become considerable. The dark lines were shifted by amounts appearing to indicate an approach of a thousand miles per second. Professor Newcomb has shown that the maximum speed that can be imparted to a star, due to the gravitative effect of the universe—certain assumptions as regard its size being made—is twenty-five miles per second; the maximum that has been observed in ordinary stars is two hundred and fifty-seven; so that this one thousand miles per second is a very abnormal speed, and seems to suggest that some force other than gravitation is at work in the case of this star.

To sum up, the following seems to be the normal course for a new star:—

It commences shining as an ordinary Helium star, which very soon displays a series of bright lines or bands, each one of which is accompanied by a dark companion of shorter wave-length. As the star fades these lines fade, and their place is taken by bands in the blue region, the object falling into the category of a Wolf-Rayet star. These bands in their turn give place to the characteristic spectrum of a gaseous nebula, which, after a greater or less length of time, is replaced by a continuous spectrum.

Each one of these phases, though lasting only for a few days or months in the temporary star, is to be found in an apparently fixed and stable condition in other stars.

LONG-PERIOD VARIABLES.

Long-period variables are distinguished from the rest by peculiarities other than the length of time taken to go through their cycle of changes. The range is almost always much greater and less regular than is the case with short-period stars, and while the latter are almost always Solar or Sirian in character, the former are invariably red stars.

The best-known long-period variable is *o* Ceti,

or Mira, as it is called, because of its wonderful performances. When first noticed (in 1596) it was supposed to be a Nova. It has a period of three hundred and thirty-one days. At the brightest observed maximum (that of 1779) it was equal in lustre to Aldebaran, while the faintest minimum took place three years later, when it faded to the tenth magnitude. The average range is from the third to the ninth magnitude, *i.e.*, a change in brightness of 1 : 250, while the maximum observed difference—from the first to the tenth magnitude—is equivalent to a light range of 1 : 4000. Spectroscopic evidence shows that the maxima are due to conflagrations of Hydrogen, which occur with approximate regularity every three hundred and thirty-one days, the cause of these outbursts being unknown. As we have seen, the intensity of the action varies very considerably, and the period also is not rigidly obeyed. For example, the maximum in 1840 occurred a month later than it should have, and variations of fourteen days are quite common. The same year the fading was more rapid than the brightening; in every other observed period the reverse has been the case. The maximum generally lasts for fourteen days, but sometimes twice as long; also the shape of the light curves varies considerably. In 1898 the blue Hydrogen lines were tripled, as though a powerful magnetic field were present; but this has never been observed since. The dark lines of the spectrum show that Mira is receding with a velocity of sixty-six kilometres per second, while the bright lines give a much lower velocity. Truly, it is a well-named star.

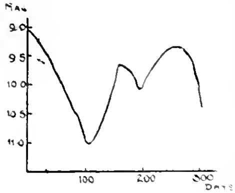


FIGURE 197. Light-curve of U Lupi.

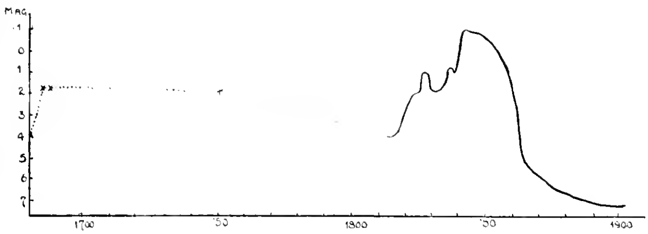


FIGURE 198. Light-curve of η Carinae.

R Normae is interesting as having a double minimum and a light-curve very much resembling that of the area of faculae on the Sun. Another point of resemblance between the two curves is that they are very irregular (see Figure 196).

U Lupi is another long-period variable, if, indeed, it has any period at all (see Figure 197). It seems to take a delight in falsifying predictions.

Remarkable as these antics are, they are completely thrown into the shade by the performances of η Carinae. This was first observed by Halley as a fourth-magnitude star in 1677. Père Noël rated it as second magnitude from 1685 to 1689, and Lacaille, in 1751, agreed with this. Burchell (1811–15) estimated it as of the fourth magnitude, and Fallows, seven years later, as second magnitude. In 1827 Burchell was astonished to see that it had risen to the first magnitude. Ten years later the star suddenly tripled its light and became equal to α Centauri. After this it faded, and then became brilliant once more, remaining almost as bright as Sirius for nine or ten years. Thirteen years later it was of the second, and the year following of the third magnitude, and in 1868 it became invisible to the naked eye. This, however, was not the end. It was followed with the telescope for sixteen years, during which time it continued to sink in brightness until, in 1886, its magnitude was 7·6. Since then it has remained at this point. What or when its next move will be, if indeed it makes any, is a matter of pure speculation (see Figure 198).

It should be noticed that in all long-period stars, no matter how irregular they may be, the rise to maximum is gradual and spasmodic, and not sudden, as in the case of Novae.

Red stars are, as a general rule, variable. At Prague Observatory twenty-two of these bodies were taken under observation: two of them were periodical, six were irregular variables, and five vanished or lost most of their light. A small red star near Y Cygni rose one magnitude between December, 1885, and January, 1886, and still keeps at the higher value. Chandler has pointed out that the redness of a variable star is, in general, a function of the length of the period of variation.

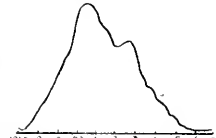


FIGURE 199. Curve of sunspot frequency (Ellis).

Reference may be made here to the well-known legend of the lost Pleiad. It is first mentioned, as then well known, by Aratus in a poem from which a quotation was made by St. Paul at Athens, and which had then been written about three hundred years. It is quite possible that in early times seven of the stars in the Pleiades were readily visible to the naked eye, and that one of them has lost a considerable portion of its light. Alcyone, the brightest star in the group, appears to be at present much brighter than in the days of Ptolemy or Al Sûfi. Professor Pickering

suggests that Pleione was the seventh or lost Pleiad. It is now just visible to keen eyesight on a clear night, and is twice as bright as Argelander estimated it to be fifty years ago.

. . . . . .

Many, and for the most part vain, are the theories that have been advanced to explain these irregular long-period variations. The only one to which we can refer at present is really a comparison rather than a theory. It is that the cause which makes sunspots increase and decrease is similar to the cause of long-period variations. The curve of sunspot frequency (see Figure 199) might well be taken for the light-curve of a typical long-period variable star. Furthermore, the development of bright lines in the stellar spectrum at maximum has its analogy in the development of flocculi and the increase in the corona of the Sun at times of sunspot maxima. At best, however, this is only one step in advance in the understanding of a very complicated subject.

(*To be continued.*)

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

THE STELLAR SYSTEM.—An interesting lecture on the Structure of the Star System was given by Professor Eddington at the April meeting of the British Astronomical Association. He gave a table showing the distance, size, velocity, and other details of the twenty nearest stars—those whose distance is less than a million times that of the Sun. He concluded that when the parallax surveys were more exhaustive about thirty stars would be found to be within this limiting sphere. Therefore the number within a sphere of four times this radius would be sixty-four times thirty, or, say, two thousand. This, then, is the number of stars that may ultimately be found to have an annual parallax of 0·″05, or greater. Smaller parallaxes than this have not at present much significance, since the uncertainty in the determination becomes practically as large as the parallax itself. Some of the stars in the smaller sphere (whose radius is five "parsecs," a "parsec" being a distance at which a star's parallax is 1″) are of the ninth magnitude. We may therefore expect that some of the stars in the twenty-parsec sphere are as faint as the twelfth magnitude. This is far fainter than the limit to which star parallaxes have at present been studied. But now that wholesale parallax determinations are being undertaken by photography it is only a matter of time before all the sensible parallaxes are detected. Professor Eddington pointed out that a noteworthy feature of our faint near neighbours was their abnormally high speed. From statistics of the star system as a whole he should have looked for a mean speed of twenty-nine kilometres per second among them, whereas he actually found sixty-eight kilometres. His explanation is that the stars which are intrinsically very small and faint have really a much higher speed than was previously suspected, but that these stars do not come into our catalogues of precision unless they are our very near neighbours, being otherwise too faint for meridian observations. Hence the study of our near neighbours has revealed a large class of intrinsically small, rapidly moving stars, of whose existence we should otherwise have remained in ignorance. This adds to the probability that on the whole the speed of stars varies inversely as the square root of their mass, a distribution which is known as "The Equipartition of Energy." Professor Eddington pointed out that this holds among the molecules of gases, but he expressed a doubt whether the condition of stars was really similar to this, in consequence of the much greater rarity of collisions. Mr. Maunder, however, reminds me that the late Mr. A. C. Ranyard anticipated a great many years ago—long before the correlation of speed and spectral type was detected—that the stars of small mass would have the highest speeds simply on account of the mutual gravitation of stars, and quite apart from any actual collisions. As they approached each other the star of smaller mass would move quicker (just as the Moon moves quicker than the Earth in their mutual monthly journey). Supposing that no actual collision occurred, most of this acquired speed would be lost again on recession, but a little would remain, and in the course of time a succession of such encounters might produce the speeds we actually find. There is at least one case of a large and massive star with a very high speed, viz., Arcturus, whose speed is estimated as two hundred and fifty miles per second. It is impossible at present to give any explanation of the manner in which this speed developed.

Professor Eddington passed on to deal with the "Giant and Dwarf Stars." Professor H. N. Russell was the first to point out that there was clear evidence that the stars of spectral type M (banded spectra) should be divided into two classes: The Giants, which are highly luminous, but at great distances; and the Dwarfs, which are our near neighbours, and whose intrinsic luminosity is very low. Since that time the evidence for these two classes has grown clearer, and a suggested explanation is that the M type marks both the beginning and the end of a star's career as a Sun. This view is elaborated in some detail by Professor Russell in the *Observatory* for April. Giant M stars on this view are very large and diffused, but their temperature has not yet reached its maximum. Their great bulk is the cause of their high luminosity. We may take Antares and Betelgeux as types. These giants are supposed to pass through types K and G, reaching type B if their mass is great enough (it has been deduced that B stars have about three times the mass of average stars, so that only stars of great mass attain this type). Then, as contraction proceeds, temperature passes its maximum and begins to decline. The spectral types are now passed through in the order BAFGKM; when the last stage is reached the star is near the end of its sunlike career, and its temperature has become low, and its atmosphere very absorbent. They are not necessarily all of small mass, though the dwarf M stars in our neighbourhood appear to be so. But if the stars all began their career at about the same time those of small mass would attain the M stage much sooner. Statistics show that, in space as a whole, the Giants are much rarer than the Dwarfs; this perhaps makes it likely that these giants are great in mass, not only in bulk, and therefore that each stage of their career is greatly prolonged. It is of interest to note that Sir J. Norman Lockyer suggested many years ago that the maximum temperature came in the middle of a star's career, and that among the lucid stars we could find examples both of increasing and diminishing temperature. He differed in the order in which he put the spectral types, but at that time there was much less information than is now available as regards correlation of distance, mass, absolute brightness, and spectral type.

The difficulty about Professor Russell's new hypothesis is the almost perfect agreement between the spectra of the giant and dwarf M stars, although their physical condition

is supposed to be utterly different; however, it may be that the differences of spectral type depend almost entirely on temperature, and that the well-known M bands, due to titanium, and so on, are simply an indication that the temperature is too low to completely volatilise these substances.

Professor Russell points out that, in cases where a star separates into two nearly equal masses, tidal action will not increase the distance between them much beyond its initial value; so that double stars that are now widely separated must have begun their career at a similar distance. He explains the number of spectroscopic binaries among stars of the A type by supposing that these have separated after the parent mass has reached a considerable degree of compression, while the more widely separated binaries of solar type separated when the parent mass was still very large and diffused.

COMETS.—Kritzinger's Comet has been an easy telescopic object in April, and is likely to be somewhat brighter in June, as it does not reach perihelion till June 4th. The following table gives its positions at 11 p.m. on the days named :—

Date.	Right Ascension.	N. Decl	Log. dist. from Sun.	Log. dist. from Earth.
	h. m. s.	° ′		
June 7	21 6 52	42 24	0·0779	9·7569
,, 11	21 22 6	43 24	0·0787	9·7679
,, 15	21 36 56	44 14	0·0801	9·7777
,, 19	21 51 12	44 56	0·0820	9·7862
,, 23	22 4 43	45 29	0·0845	9·7932

It will be due south at 4 a.m., but from its high north declination it will be observable throughout the night.

Delavan's Comet has become a morning star, but it will scarcely be observed before the middle of July, owing to its proximity to the Sun.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

CHEMICAL TEST OF PREGNANCY IN ANIMALS.—An ingenious method of recognising pregnancy in its earliest stages from the results of an examination of the blood of the animal has been devised by Dr. Abderhalten, and is described in outline in the *Bull. Agric. Intell. and Plant Diseases* (1913, XIV, 1745).

It is based upon the fact that an enzyme, possessing the property of breaking down the proteins of the placenta, develops in the blood of a pregnant animal, and disappears again about ten days after the birth of the young animal.

In testing for this enzyme, some of the blood serum of the animal is mixed with placenta-protein, derived from an animal of another species, and placed in a membrane which is suspended in water (containing toluene as a preservative) and incubated at 37° C. for sixteen hours.

The solution which has dialysed through the membrane is then tested with a hot one-per-cent. solution of ninhydrine (triketo-hydrindene hydrate) and if, after cooling, a deep blue colour is produced, the presence of the specific enzyme is indicated, and the animal is pregnant. In the absence of the products of this enzyme the dialysed solution will not react with ninhydrine, and it may be inferred that the animal is not pregnant.

A FIRE-DAMP WHISTLE.—The requirements of an indicator for fire-damp (methane) in a mine are that it shall be simple, sensitive to the gas, and readily handled by the miner. The Davy Safety Lamp fulfils these conditions, and shows the presence of fire-damp by the appearance of an aureole round the flame, the size and intensity of which increase with the proportion of methane. It has the drawback, however, that the flame may, under certain conditions, cause ignition of the gas outside the lamp, and several explosions have been traced to this cause.

To obviate the danger, Professor Haber has devised an indicator based on acoustical principles (*Journ. Soc. Chem. Ind.*, 1914, XXXIII, 51). Essentially, this consists of a brass cylinder containing two small pipes, which are tuned to give the same note in air, and these are blown with the same current of air from a hand-pump, which forms the outer sleeve of the cylinder. Membranes are interposed to prevent the current of air from entering the pipe tubes, or resonators, and the space beyond each pipe thus forms a closed gas chamber. The pitch of the note given by the pipe will therefore depend upon the nature of the gas contained in each chamber.

In the case of one pipe the chamber is filled with air from outside the mine, while the air from the mine is brought into the closed gas chamber of the other pipe, after being filtered through soda-lime to remove dust, moisture, and carbon dioxide.

If the air of the mine contain methane, the two pipes, when sounded by means of the hand-pump, will give beats, the frequency of which will increase with the proportion of the dangerous gas. When the amount of the fire-damp approaches the explosion limit the beating of the notes of the two pipes will produce a characteristic "trill," which will warn the miner to withdraw.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

NICKELIDE OF IRON.—In an investigation of the chemical and mechanical relations of iron, nickel, and carbon, Professor J. O. Arnold and Professor A. A. Read found that in alloys of nearly pure iron and nickel a critical mechanical point exists at about thirteen per cent. of nickel. This percentage corresponds with the formula Fe_7Ni, and it would appear, therefore, that there exists a definite alloy of iron and nickel of this composition. This alloy is remarkably tough, and has much the highest tensile strength of the whole series. A steel containing 13 per cent. of nickel and about 0·55 per cent. of carbon was sufficiently hard to defy machining, the hardness of the alloy itself being here augmented by a large quantity of dissolved nickel carbide.

BRONZE.—As bronze alloys are largely used at the temperatures of high-pressure steam, it is of the greatest importance to know how the strength of such alloys changes at these temperatures, and in a paper read before the Institute of Metals by Mr. John Dewrance, the results of tensile tests made at different temperatures are given. Gun-metal composed of copper (eighty-eight per cent.), tin (ten per cent.), zinc (two per cent.), was found to lose its strength rapidly with rising temperature, from 350° F. The addition of 0·5 per cent. of lead, however, caused the strength to be maintained up to 550° F. The author suggests that, as lead has this effect, it is probable that further investigation might prove that some other ingredient might preserve the strength of bronze at even a higher temperature.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

THE LATE EDUARD SUESS.—With the peaceful close of the life of Eduard Suess geography and geology lost perhaps their largest-minded and best-known student. Born in London in 1831, the eldest son of a German wool-merchant, Suess might have been claimed by the British School but for the fact that on the rise of the Australian wool industry the German waned, and his parents went to Prague. They became interested in a large business firm in Vienna, and their son at first entered the business.

His natural bent soon asserted itself, and at the age of nineteen he published some notes on the geology of Carlsbad and the mineral waters. In 1851 he entered the Imperial Museum of Vienna as an assistant, and spent the following ten years of his life in the study of the vast palaeontological collections of the museum. In 1857, with a reputation as a biologist and geologist already made, he became Professor of Geology in the University of Vienna.

He had already thought much on the problems of palaeogeography, and studied them widely. A rare gift was his of grasping details, and yet of seeing each in its true relation. From the most complex mass of detail he could pass securely and easily to general principles. In 1875 he had matured his views on evolutionary geography, and in that year published a small work, "Die Entstehung der Alpen." Ten years later the first volume of the epoch-marking "Antlitz der Erde" appeared. With its appearance the now well-known teaching of Suess obtained its recognition, and within twenty years the Oxford translation into English of Dr. H. Sollas, and the valuably annotated French edition of M. de Margerie, had begun to be published.

The contributions Suess thus made to science are too well known to be recapitulated here. They place his beside the names of Darwin and Lyell in the honourable roll of science. Of his activities in other spheres a word may be said. In 1862 the sanitation and water supply of the city of Vienna were in a most unsatisfactory condition. In that year he wrote an essay on water supply which attracted attention, and in the same year he found himself a member of the City Municipal Council. At his instigation a pure water supply was brought to Vienna from the Alps by means of an aqueduct one hundred and ten kilometres long, and the citizens testified to their appreciation of the work by conferring on Suess their highest honour. He subsequently spent thirty years in honourable and distinguished service in the Austrian Parliament.

Professor Judd has spoken elsewhere of the rare and kindly characters which marked Suess in his relations with his fellows. He seems to have recollected with pleasure his infant connection with this country, and the Royal Society of London, expressing their appreciation in concert with the learned societies of the globe, elected him a foreign member, and awarded him the Copley medal. He was also a Wollaston Medallist of the Geological Society.

AN ANGLO-SWEDISH ANTARCTIC EXPEDITION.—For many purposes the period during which exploring parties are in residence in polar regions, making continuous observations, is too short. From Sweden comes the suggestion that in 1915 an expedition should proceed to the part of the Antarctic Continent opposite South America, and continue its work there until 1920. A continuous series of observations covering five years would be invaluable for the elucidation of climatological and glaciological problems. Professors J. G. Anderson and O. Nordenskjöld are the initiators of the scheme. Sufficient money has been promised in Sweden for acquiring a vessel and erecting a commodious station at the main base. Of the annual cost of maintenance the Swedish Parliament is expected to provide half, and there is promise of the other half being raised in this country. Whaling companies, operating in the neighbourhood of South Georgia, are depended on for aid in transport of provisions and plant, and in maintaining communications with the outer world. The scientific staff will consist of a geologist, two biologists, a cartographer, a meteorologist and geophysicist, and a surgeon. Two of these will be English.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

FURTHER DISCOVERIES AT PILTDOWN.—Very careful search of the gravel-pit at Piltdown, in which the famous skull of *Eoanthropus dawsoni* was found, has led to further discoveries, described in *The Quarterly Journal of the Geological Society*, April, 1914. The most important find is a human canine, which, according to Dr. Smith Woodward, almost certainly belongs to the skull of *Eoanthropus*. There were also found two human nasal bones, and a turbinal—the latter, however, in very bad condition. Additional mammalian remains found in 1913 were a fragment of a tooth of *Stegodon*, and an incisor of a beaver (*Castor fiber*).

Dr. Smith Woodward believes that the nasal bones resemble those of the existing Melanesian and African races, rather than those of the Eurasian type. The canine tooth, however, "is distinctly larger than any hitherto found in the genus *Homo*, and differs fundamentally in having completely interlocked with its opposing tooth, which worked downwards on its inner face as far as the edge of the gum." The permanent tooth of the extinct *Eoanthropus* is almost identical in shape with the temporary milk-tooth of present-day man, and it is concluded that the resemblance between *Eoanthropus* and man is greater than that between the former and any known ape.

The gravels at Piltdown have now been divided into four distinct beds. First, there is surface soil, one foot thick, containing subangular flints, flint-implements of all ages, and pottery. Below this comes a sandy loam, two feet six inches thick, with lenticular patches of dark ironstone gravel and subangular flints. In this bed one Palaeolithic worked flint was discovered. Then comes the bed, at the base of which *Eoanthropus* was found. This consists of a dark ferruginous gravel, with subangular flints and tabular ironstone, and containing, besides *Eoanthropus* remains, Pliocene rolled fossils, *Castor*, *Stegodon*, etc., "eoliths," and one worked flint. This bed is eighteen inches thick, and has a floor covered with depressions. Finally, there is a bed, eight inches thick, of yellow, finely divided clay and sand, believed to represent a mud reconstructed from the underlying strata (Tunbridge Wells Sand). Mr. Dawson believes that the fossiliferous bed is mainly composed of Pliocene drift, probably reconstructed in the Pleistocene epoch.

METEOROLOGY.

By William Marriott, F.R.Met.Soc.

PHENOLOGICAL OBSERVATIONS, 1913.—At the Meeting of the Royal Meteorological Society, on April 22nd, Mr. J. E. Clark and Mr. R. H. Hooker presented their Report on the Phenological Observations from December, 1912, to November, 1913. This dealt with the dates of flowering of plants, the song and migration of birds, the appearance of insects, and also the character of farm crops. The chief characteristics of the weather were an open winter, a wet spring, a summer very dry, but neither sunny nor warm, and a uniformly mild autumn. The mean dates of the flowering of the thirteen selected plants for the British Isles were:—

Hazel	Feb. 12	1 day early
Coltsfoot	,, 22	14 days early
Wood-anemone	Mar. 25	5 ,, ,,
Blackthorn	April 4	7 ,, ,,
Hedge Mustard	,, 20	4 ,, ,,
Horse Chestnut	May 11	average
Hawthorn	,, 14	2 days early
White Ox-eye	,, 31	average
Dog Rose	June 6	5 days early
Black Knapweed	July 7	3 days late
Harebell	,, 11	1 day late
Greater Bindweed	,, 13	1 day early
Ivy	Sept. 29	average

With regard to birds the mean dates for the British Isles were:—

Thrush first heard	Jan. 18	5 days early
Swallow first seen	April 19	1 day late
Swallow last seen	Sept 30	12 days early

Cuckoo first heard	April 26	3 days late
Flycatcher first heard ...	May 17	2 days late

The mean dates of the first appearance of insects were :—

Honey Bee	Feb. 23	3 days early
Wasp	April 14	1 day late
Small White Butterfly ...	May 2	13 days late
Orange Tip Butterfly	,, 11	average
Meadow-brown Butterfly	June 19	5 days late

With regard to the crops, wheat was just under average; barley in England was not much below average; oats, which require plenty of rain in the early summer, were very deficient in England, but satisfactory in the moister Scotland and Ireland. Potatoes were a heavy crop everywhere. Roots were deficient in England, especially in the drier Midlands; in Scotland and Ireland roots were very good. Hops were a poor crop, and a special feature of the season was the unusual difficulty of estimating the yield until the hops were picked. The hay crop was abundant, and an interesting feature is that, in the South and Midlands, the hay from clovers and rotation grasses was, relatively much better than that from permanent meadow land. Harvesting began, in England, at about the average time—a shade earlier in the case of wheat, a little later in the case of oats In Wales it was a little later. There was a tendency for the dates to be rather earlier on the eastern side of the country than in the west. The duration of the harvest was also about an average, and rather longer than usual in Wales; in this case also it was distinctly shorter in the east than in the west. The explanation is that in the moister and somewhat later western west and north the broken weather set in in September, before operations were completed; whereas in the south the corn had mostly been got in before the conditions became unfavourable. The quality of the crops was good in the case of wheat and barley, but that of oats was less satisfactory.

WHAT IS A MILLIBAR?—In the April number of "KNOWLEDGE" reference was made to the fact that the U.S. Weather Bureau had adopted the C.G.S. units for the daily charts of the Northern Hemisphere, the issue of which began on January 1st, and that the Meteorological Office had also employed these units in the *Monthly Weather Reports*. From May 1st the Meteorological Office has introduced these units into the *Daily Weather Reports*. The barometer readings are consequently now given in millibars, and the isobaric lines are drawn for centibars. The amounts of rainfall are also given in millimetres instead of inches.

The absolute unit of pressure on the Centimetre-Gramme-Second system is the dyne per square centimetre. As this unit is exceedingly small a practical unit one million times as great has been suggested. This unit, the megadyne per square centimetre, is called a "bar." In the *Daily Weather Report* the centibar and the millibar, respectively the hundredth and the thousandth part of the "bar," are adopted as working units. The relation between the millibar and the inch of mercury is given in the following table:—

Millibars.	Mercury Inches.	Millibars.	Mercury Inches.
960	28·35	1010	29·83
965	28·50	1015	29·97
970	28·65	1020	30·12
975	28·79	1025	30·27
980	28·94	1030	30·42
985	29·09	1035	30·56
990	29·24	1040	30·71
995	29·38	1045	30·86
1000	29·53	1050	31·01
1005	29·68	1055	31·16

On the weather map in *The Times* newspaper the isobars are now given in centibars, with the equivalent English inches at the other end of the lines. If this method be continued, those who consult the weather maps will, in the course of time, get accustomed to the new values.

Messrs. Negretti & Zambra have made an attempt to harmonise the various scales by preparing an aneroid

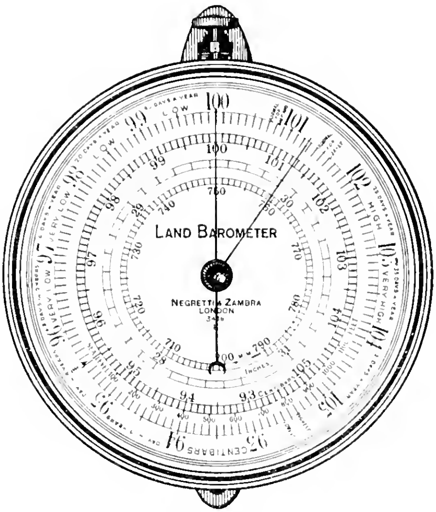


FIGURE 200.

with a new dial, as shown in Figure 200. The outer scale is figured in centibars, and subdivided into millibars, and may be set to the altitude of the place. The next inner dial gives the actual pressure in millibars, whilst the two inner scales are divided into inches and tenths, and millimetres, and indicate the height of the mercury in an ordinary barometer.

MICROSCOPY.

By F.R.M.S.

Microscopical work, taken up as a relaxation, is no doubt mostly done in the winter; but we would like to point out, particularly to those who are beginning to study, that much interesting material can be collected in the open air during the summer. We therefore propose to publish a series of some notes and photo-micrographs bearing upon the subject by Mr. Harold S. Cheavin, whose name will be well-known to our readers.

I.—THE WATER-BEETLE (*DYTISCUS MARGINALIS*).—The savage Beetle of the pool, the diving Beetle, or the ferocious and carnivorous Beetle of the pool, are terms used by various writers in describing this familiar form of Beetle, so often met with in our country walks.

In the pools situated in quiet places, especially on the moor lands, the various forms of Water-beetle are found during the spring and summer months to be extremely abundant, either in the larval stage or as fully developed insects.

Darting through the water in quest of its prey, or rising to the surface, replenishing its air supply, the Water-beetle is seen to great advantage. The female insect, during the months of March and April, will be found to be very busy laying its eggs in small incisions made by the pointed ovipositor in the leaves and stems of water-plants, and in each incision only one egg is placed.

In about three weeks the eggs produce minute larvae, which grow very rapidly in the presence of an abundance of food, reaching full size—viz., two inches long—in four or five

FIGURE 201. Head and breathing [illegible] larva. × 32.

FIGURE 202. [illegible] Water-beetle.

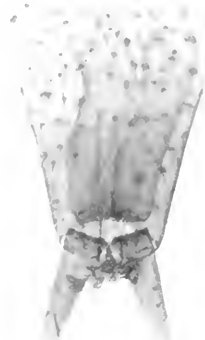


FIGURE 203. [illegible]

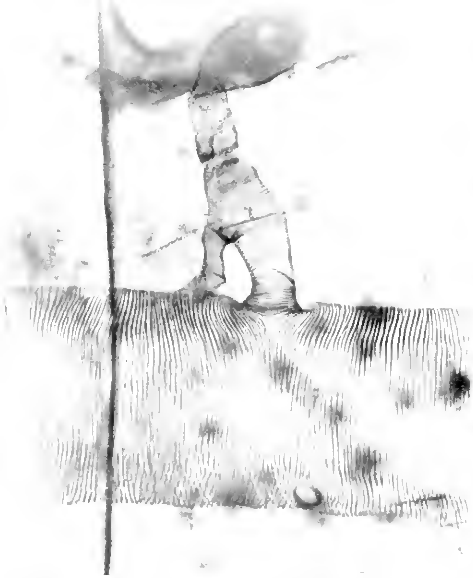


FIGURE 204. One of the [illegible] of the Water-beetle larva, showing sp[illegible] below the tube branches, leading towards [illegible] × 300.

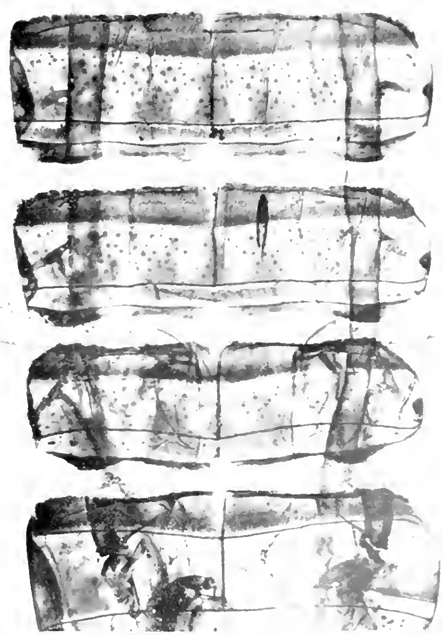


FIGURE 205. The tw[illegible] of the [illegible] together at the base, and [illegible]

FIGURE 206. Antenna of Water-beetle. × 30.

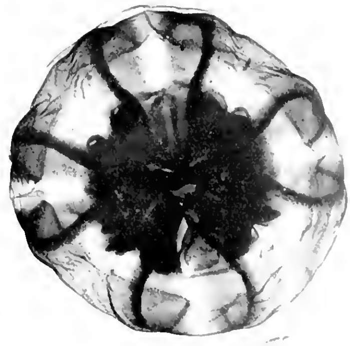


FIGURE 208. The gizzard of a Water-beetle. × 30.

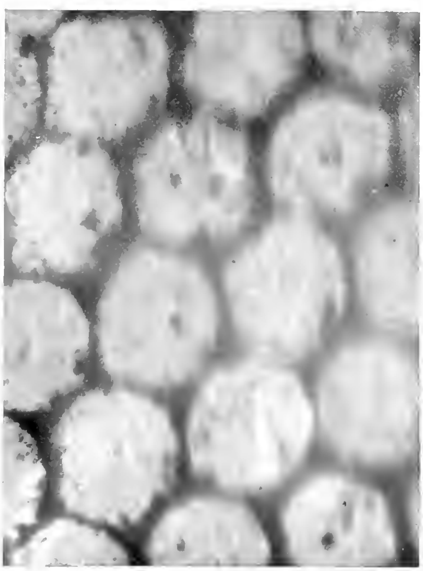


FIGURE 207. Part of the cornea of a Water-beetle eye, showing the hexagonal areas known as "facets." × 800.

FIGURE 209. The main ganglion of a Water-beetle, showing nerve-threads attached. × 16.

weeks, each larval change in size being carried out by casting the chitinous covering.

When fully grown (see Figure 202) the larva is yellow-brown in colour, cylindrical in shape, and tapering to a point towards the tail-end; the head is very ferocious-looking, and is joined to the thorax by a distinct neck.

The mouth organs are very powerful, and the carnivorous impulses of the larvae cause them to play havoc amongst other inhabitants of the pond in which the larva lives.

Tadpoles, young fish, are all seized with great energy, once they come within the reach of the mandibles, and even other larvae, consisting of brothers and sisters, are quite welcome as food for this carnivorous aquatic larva. Thus, several larvae should never be placed in the same aquarium or amongst other larval forms of insect life, for in all cases only one inhabitant will be found as a survivor.

The mandibles (see Figure 201) are large, sharp, conical-shaped, claw-like organs, and are controlled at the base by powerful muscles. The prey is seized by these mandibles and pierced with the sharp ends, which make a small puncture in the body of the victim. The mandibles are hollow, and through a small hole, situated near the tip, the blood of the victim is sucked by means of the action of the pharyngeal pump, during which period the mouth is closed. The passage of the blood-flow from the victim can be seen by means of a microscope, and especially well if the blood is red, because the jaws and body of the larva are very transparent.

The mouth found between the lips (see Figure 202) is only used for devouring the solid pieces of the prey; the body of the victim is broken up by the mandibles, and the solid parts are then taken in.

The larva is lighter than water, and, to remain below, it is necessary for the mouth parts to grasp the stems of water-plants; to release hold, the jaws are relaxed, and the body of the insect at once rises to the surface of the pond. This rising to the surface is essential for breathing purposes. Like all other insects, the larva is dependent on air being taken into its body. The larva remains suspended by its tail from the surface-film of the water, and the air is taken in by two openings, known as "spiracles," situated at the extreme tip of the tail. These spiracles lead to the large longitudinal air-channels, one on each side of the body, known as "tracheae."

The two long processes found projecting at the tail (see Figure 203) are covered with very fine hairs, and serve to suspend the larva. Holding on to the surface-film of the water, they appear tubular, and one would imagine that air is taken in through these tubes; but this is not the case. The tracheae are long elastic tubes, and in the larva can be seen, one on each side, as black lines. These tubes have a spirally thickened inner layer of chitin, which keeps them always expanded (see Figure 204). A similar example can be found in garden hose or gas-tubes having internally a spiral wire, to prevent damage when the tube is trapped or suddenly bent on itself. Examination under the microscope shows that these tracheae branch off into smaller tracheae, and in the larvae lead to closed spiracles, the latter only becoming functional when pupation is complete. The spiracles in the larval body are arranged one on either side of each segment (see Figure 205).

The larva, on pupation, ceases taking in food, and seeks out some soft earth on the edges of the pond. Here it digs out a cavity, and works for twenty-four hours unceasingly. If the cavity be not finished, it will rest for the same period, viz., twenty-four hours, and recommence its labours, till the cell cavity is complete. When finished, the larva pupates in practically any position, and the change takes about fourteen days; the larval skin splits along the back, and the whole is cast off at the tail-end.

The period of pupation into the fully developed water-beetle varies somewhat, for in summer it lasts about fourteen days, but in winter it is very prolonged, and continues from any time up to spring. The exact period is at present an uncertainty.

The fully grown beetle eventually develops, and is seen to creep out of the burrow. At first its colour is very light, and it takes several days before the familiar dark-bronze appearance is assumed.

The adult water-beetle presents many new features, but the intense voracity and ferocity present in the larval stage are in no way diminished, and the carnivorous instincts are always present.

We have as a new feature the long antennae (see Figure 206), consisting of many-jointed conical-shaped parts, which seem to diminish in length towards the apex. Both the antennae, or feelers, as they are sometimes termed, are the same in both sexes of the insect; and as for their particular purpose their functions and use are at present undetermined, beyond the fact that, as in other insects, some sensory features are assumed to be possessed by them.

The eyes of the insect are very large, and protrude from each side of the head, immediately below the antennae (see Figure 207). As in many other insects, the eyes are of compound form, and consist of a very large number of hexagonal areas, known as facets: these facets in the Water-beetle produce multiple images.

When the cornea containing these facets is mounted flat, and the slide so prepared examined microscopically, the facets will be found to produce an image of a photograph in each area, under proper illumination; the image so obtained, however, is blurred.

In the eye of the insect the facets form the base of a pyramidal tube, and the apex is covered by a nerve sheath, which communicates the eye with the optic lobes of the brain ganglion (see later).

The pyramidal tube is covered also with a sheath, containing pigment grains, which serve to allow only straight rays of light, or central beams, to pass through the centre of the hexagonal area.

The nerve centres of the water-beetle are rather peculiar, and consist of ganglia, as they are termed, placed in the thorax and abdomen. In theory every segment of the body has one pair of ganglia; but by fusion and suppression the ganglia appear more complex.

The brain consists of three fused pairs of ganglia, divided into three divisions:—

(*a*) Parts forming optic lobes supplying the eyes;
(*b*) Parts supplying the antennae;
(*c*) Parts supplying the mouth and salivary glands.

Each division sends out nerve-threads; and, further, the ganglia in the other parts of the body appear to be made up of segments, having attached a large number of nerve-threads, which ramify in the various organs, such as those relating to movement (see Figure 209).

The gizzard, or crop, as it is better termed, is situated next to the oesophagus, and communicates finally with the rectum and anal glands. These parts, taken as a whole, form the alimentary canal of the water-beetle (see Figure 208). Food is stored or held in this crop, and practically the whole of the digestion is carried out here by means of the alkaline saliva, which converts the starch present in the food into sugar. The latter, being very soluble, is easily carried through the walls of the canal into the blood. An acid secretion is also passed forward into the crop from the ventricles, and this secretion emulsifies the fatty portions of the food and converts the albuminous products into peptones.

W. Harold S. Cheavin, F.R.M.S., F.E.S.

(*To be continued.*)

A FUNGUS-INFESTED MOSS.—The object of the present short article is to illustrate certain unlooked-for appearances which both interested and astonished the writer at the time, who now hopes they will prove of interest to the readers of "Knowledge." The specimen under observation was of the ordinary Wall Moss (*Tortula muralis*, see Figure 213), found growing in large numbers upon a brick fence wall in Finchley. After a piece had been placed in water upon the usual glass slip with a thin cover over it, the writer was astonished to see, after a time, the stem and urn of the moss break out in

places into what seemed a violent irruption, as shown in Figure 210, under a two-inch objective. To the writer the scene was vastly realistic. It wanted but little imagination indeed to conceive the whole as a landscape, with volcanoes in the distance, craters and all; to conceive the observer as watching the irruptions from a point so far off that sound was swallowed up, still leaving the weird effects distinguishable to the vision. This may seem far-fetched, yet such was the impression conveyed, even to the point of forgetting that one was only looking at a moss through the microscope.

Recovering from the glamour, the first thought after was that here was something new in the life-history of the mosses; that not only did the urn partake, but also the supporting stem, in the production and emission of spores. This indeed would have been something of value to set before the scientific world. Second thoughts, however, due to appearances, soon convinced one that here was the work of an enemy, who had not only taken possession of his host, but had also destroyed him, and was now busily engaged in propagating his own kind. In other words, we were dealing with a fungus, and not a moss at all.

Substituting now another objective, and a power of five hundred diameters, the whole tracks of the eruptions were resolved into countless thousands of characteristic fungus spores. Of what particular genus they were the writer will not pretend to say, since this was only one stage of the life-history, neither is he learned in fungi. Figure 211 shows the appearance of the spores when first emitted; Figure 215, twenty-four hours after; and Figure 216, after three days.

It is stated by De Barry and others that the fungi differ from the green plant in the fact that although the complete organism in the first may be produced from a single spore, yet it is more often the outcome from a quantity of spores combining. Certainly they all seem, in Figure 216, as if working together for a common purpose, yet to what particular end further researches only could show. The theory of a colony will account for the enormous fecundity of spores in the fungi. The green plant, even the giant forest tree, is the product of one seed, or spore, only, while hundreds or thousands of spores may go to the making up of one fungus alone. It almost makes the mind reel while attempting to think this out; for here we are not dealing with consciousness as understood by us; yet each individual of this compound plant must be primed with the instinct to do the same thing, at the same time, at every stage of its development. Take the common mushroom, for instance. It remains underground, concealed from all eyes, while silently preparing for its last stage of reproduction; then suddenly shoots through in a single night, and effects its purpose.

May the writer here mention a little incident, of his own observing, as having some bearing upon the manner in which this apparent miracle is performed? Within a glass preserve jar, containing a vegetable infusion, a fungus also had intruded, which, from the after-effects revealed, was one that under normal conditions spent most of its life underground. There was great interest in watching its progress day by day, but one morning found it apparently missing. After a time, however, and much looking about, it was discovered at the end of a long stalk, leaning over the edge of the glass, seemingly much interested in what it saw there. The other end of the stalk still remained in the water, some two inches down. The head contained the spores, and, from further observation, what had happened was this: Each cell of the rudimentary stalk, thick before, had suddenly elongated, projecting the whole upwards until the head reached the top of the jar, and more. Surely, never since Alice in Wonderland found herself suddenly nine feet high, with her head struck against the roof of the hall, had there been such a transformation as this.

Figure 212 was taken from the urn of the moss, after the emission of the fungus spores. So entirely occupied had it been by the intruding enemy as now to be almost transparent, clearly showing the cells of the envelope. Some half-dozen protuberances, seen in profile only on the stalk, are here found scattered in plan over the surface of the urn, like so many miniature volcanoes. Each has a small round crater in the centre, through which the spores were ejected until all was emptied. How first formed does not come within the purview of this article. Indeed, the writer does not know, only that this was the prevailing feature in all the specimens examined; that only through them the spores were projected. From some only a few came, then suddenly stopped; from others they rushed out in great force, twisting about in corkscrew fashion, as shown in Figure 210.

Of course, it must be understood these demonstrations were only induced after the application of moisture. They point to this, however, that the parasite in question depended upon rain or dew for the delivery of its spores, in order to set out and infect other green plants. There is room for much moralising here, on the same rain falling upon both the just and the unjust, but the writer is merciful.

Figure 214 is from the urn of another specimen, showing a further growth of the mycelium outside, after the expulsion of the spores. In how far this is normal is a moot question. What it does prove is that the whole of the urn and stem is filled with it, to the destruction of the green plant. In some instances the spores of both fungus and moss were found within the same urn. Only one end could be expected from a mingling like this, but so far as the examination went the end was not yet. In conclusion, here is much interesting work for any microscopist prepared to carry the investigations further.

T. F. SMITH.

THE QUEKETT MICROSCOPICAL CLUB.—At the meeting of the Quekett Microscopical Club held on April 28th a new low-power substage condenser, calculated by Mr. E. M. Nelson, F.R.M.S., and made by Messrs. C. Baker, was described and exhibited. With top lens on, its focus is one inch, N.A. ·55; and with top off, its focus is two inches. A simple centring stop holder for dark ground illumination, which Mr. Nelson had designed, was also exhibited.

Mr. N. E. Brown, A.L.S., gave an account of "The Fertilisation of *Vinca minor*." The remarkable structure of the flower was described at length, and the extreme rarity of its fruit, both in this country and on the Continent, was mentioned. Nearly all the plants found in one locality are probably the products of one plant, and have not come from seed.

Mr. Jas. Burton (Honorary Secretary) read a note on, and exhibited a specimen of, "An Abnormal Form of *Arachnoidiscus ornatus*." The normal form resembles an ordinary "chip" specimen box. In the form under notice the sides of the "lid" remained shallow, as in the normal form, but the "sides," or, as it is usually called, the "girdle," of the bottom of the box is greatly elongated, giving the diatom, when viewed sideways, the appearance of a cylinder instead of little more than a disc. There is no indication that the unusual form is due to the beginning of the process of subdivision. In the normal forms the average depth is 30μ; in a case where subdivision was far advanced, 54μ. In two abnormal specimens the values were 96μ and 105μ respectively. The diameter in both normal and abnormal forms is practically constant, about a mean of 110μ. The abnormal form is only known to occur in one collection of material from Mauritius, and, even in that, the percentage is very small.

THE BINOCULAR MICROSCOPE.—It is doubtful whether any more interesting development in microscope construction has taken place in recent years than the reïntroduction of the binocular microscope in a form suitable for use with high, as well as low, powers. The binocular instrument has been used in this country for low-power biological work for many years; in fact, the Wenham binocular is still the favourite instrument among amateurs of a particular type. That the use of both eyes with any

FIGURE 210. Stem of Figure 213 showing [illegible] eruption of fungus spores.

FIGURE 211. The fungus spores magnified 500 diameters at the time of eruption.

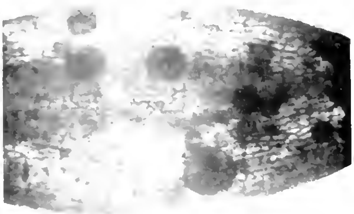


FIGURE 212. Urn of moss emptied of the fungus spores, showing the craters [illegible].

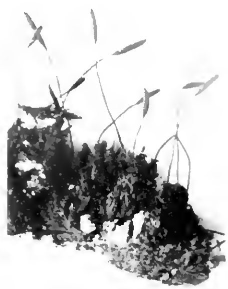


FIGURE 213. *Tortula muralis* or allied species.

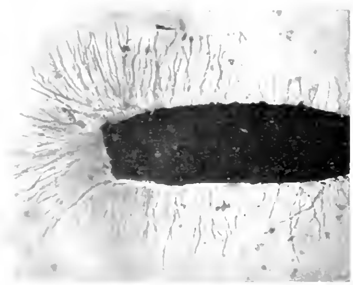


FIGURE 214. Urn of moss showing the growth of the inside mycelium after the ejection of the fungus spores.

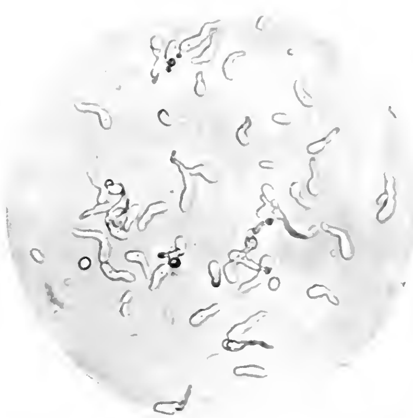


FIGURE 215. Some of the spores seen in Figure 211 sprouting, after twenty-four hours.

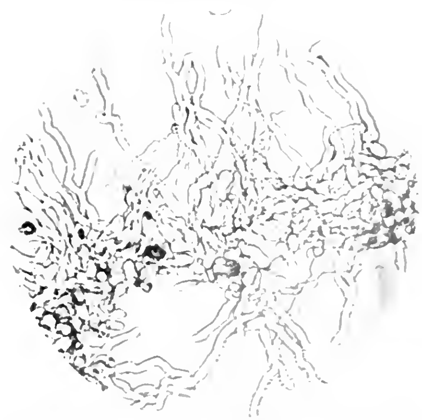


FIGURE 216. Growth of the spores seen in Figures 211 and 215 after three days.

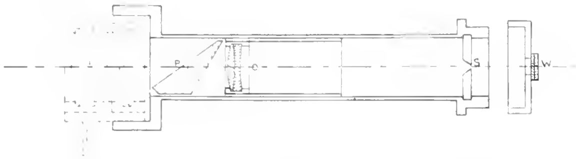


FIGURE 217. A simple Spectroscopic Attachment for converting an ordinary camera into a spectrograph. S, slide. O, small achromatic lens. P, dispersing system. W, neutral tint wedge.

FIGURE 221. An original Phonographic Record on a disc 120 millimetres in diameter.

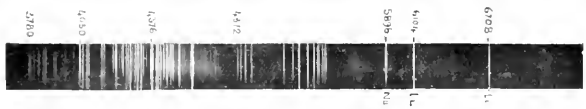


FIGURE 218. Arc Spectrum of iron with lithium and sodium, between wave lengths seven thousand and three thousand eight hundred. This photograph was taken with the apparatus shown in Figure 217.

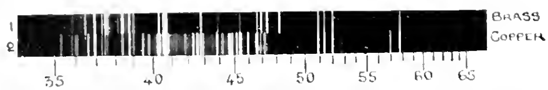


FIGURE 219. A Comparison Photograph of the arc spectra of copper and brass. The light coming from an unknown sample is allowed, first of all, to pass through the lower part of the slit, then the light from the standard through the upper portion by means of a sliding plate containing two apertures.

FIGURE 222. An enlargement by Monsieur Le Roy's method, of the disc shown in Figure 221 to 190 millimetres in diameter.

FIGURE 220. a: a photograph showing the sensitiveness of a plate made sensitive to red light. b shows the sensitiveness of an ordinary plate.

FIGURE 223. The Phonographic Record seen in Figure 221 reduced to 80 millimetres in diameter.

Figures 217-220 illustrate Mr. F. Stanley's note on "Simple Spectroscopic Apparatus" (see page 230).

Figures 221-223 refer to Dr. Gradenwitz's remarks on "Enlarging Phonographic Records" (see page 231).

optical instrument is an advantage of no mean order is beyond question, providing that no loss of accuracy of delineation results. The vision so obtained is not of necessity stereoscopic; in fact, in the form of binocular here referred to, and now being made by Leitz,* no claim is set forth under this head. The main advantage is that both eyes are used, so that no strain is thrown on either the one in use or the inactive one. All workers with the monocular microscope of any experience can use either eye for purposes of observation, while keeping the unused eye open. Many workers even then feel that the unused eye becomes fatigued, some even asserting that it suffers more than the one in use. By means of the binocular instrument this form of eye-strain is entirely avoided, and in addition any inequality of sensitiveness to colour appreciation, or to accuracy of observation of fine detail, is entirely done away with. In the form of instrument here described the two images are identical. The brightness of the fields of view should be exactly equal, but in actual practice some difference may be appreciated—a point, however, that is of very minor importance.

Figure 224 shows the general appearance of the instrument, the box-like attachment containing the system of prisms with the two eyepieces at its upper end. The separation of the latter can be adjusted, by means of a milled head, to suit the interocular distance of the observer. The distance apart can be varied between fifty-four and seventy-four millimetres, a millimetre scale indicating the correct setting to be made for observation. As the two eyes are generally of unequal strength, it was found necessary to fit an independent adjustment on one of the eyepieces. The usual way is to focus by coarse and fine adjustment, using the fixed eyepiece only, then the proper setting apart is given to the two eyepieces, and finally, if necessary, a further adjustment by the movable eyepiece is made. The internal arrangement of the prisms is shown in Figure 225. In the cemented prism nearest to the objective will be found a semitransparent coating of silver, which effects the physical division of the pencils of rays, one-half of the light passing through the silver film, and the other half being reflected.

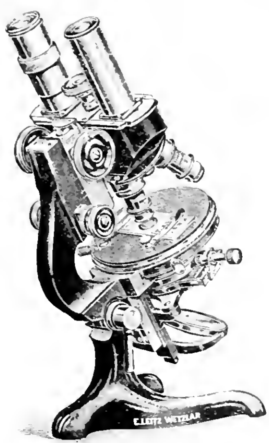


FIGURE 224.
The Leitz Binocular Microscope.

There is nothing novel about the arrangement of the prisms; on the contrary, it has been variously applied to optical apparatus in this and other modifications. It is technically possible to adjust the film of silver so that the transmitted and reflected beams are practically of equal intensity. The thickness of the glasses is chosen so that the lengths of the optical paths are equal to the right and to the left, thus securing equal magnification. The image is viewed by means of two parallel eyepieces, and this is perhaps the only point in the instrument that may give rise to criticism. In the original paper read before the Royal Microscopical Society the subject is dealt with quite fully, and the reasons for adopting the arrangement are indicated. In actual practice, however, there is no doubt that some observers are conscious of a slight temporary sensation of eye-strain after using the instrument, and the writer is one of those few. It may easily be that it arises, not from any fault in the instrument, but is due to the fact that the method of observation is a new one calling into play unusual efforts on the part of the eye for accommodation and for convergence. If so, all that is needed to overcome any preliminary difficulty is practice and regular observational work. That the instrument constitutes an important advance in microscope construction is beyond question; in fact, it is hardly too much to say that for accurate research work, involving long periods of observation, it is likely to become, not merely advisable, but necessary. It is only those who have had occasion to work for long periods with a monocular, particularly in the study of biological processes, who can really appreciate the relief that the binocular brings. Messrs. Leitz are to be congratulated on initiating a new epoch in microscope design which, while it does not carry us any further, so far as increase of resolution is concerned, yet does place in the hands of the worker a method which will tend to enhance accuracy of observation.

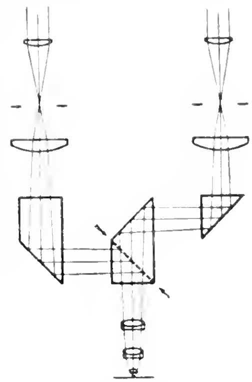


FIGURE 225.

J. E. B.

PHOTOGRAPHY.

By EDGAR SENIOR.

PHOTO-MICROGRAPHY BY MEANS OF SHORT-FOCUS PHOTOGRAPHIC LENSES.—Although microscope objectives having focal lengths of three, and even four, inches may be obtained, which are suitable for photographing comparatively large specimens at a low magnification, such as small shells, pieces of decayed wood, metal fractures, and such-like objects, it is in many respects preferable to employ short-focus photographic lenses, such as the planar and similar objectives made by Zeiss and other makers, since, these lenses being corrected for photographic purposes, there is no difference of focus to allow for, and, further, the ratio of their aperture to the focal length is such that they possess greater penetration or depth of definition, and at the same time the field is flatter. Then, again, when photographing insects, or anything where it is desired to include the whole of the object (especially when this is a large one), we are compelled to use such lenses, as no low-power microscope objective includes a visible area of the object greater than sixteen millimetres (five-eighths of an inch) in diameter. We have before us as we write a photograph of fossil wood from coal taken with a Zeiss planar, stopped down to F 11. The definition over the entire field is perfect: the vascular and cellular tissue—which leads to the inference that the greater portion of the vegetation that supplied the coal-beds belonged to the family of the firs—is well shown as a general view, and only requires further magnification with a higher power to become at once distinctly apparent. Lantern slides made from good negatives taken in this way become of great assistance either in class-teaching or in the more popular form of lecture. In taking these photographs the objective can either be employed attached to the camera and a supplementary stage used, in place of the microscope one, or the

* "The Binocular Microscope," by F. Jentzsch, *Journal of the Royal Microscopical Society*.

lens can be attached to a funnel-shaped cone which can be screwed into the short-body tube of the microscope, but in no case is the eye-piece made use of. The latter method is perhaps preferable, with transparent objects, as then the illuminating apparatus attached to the sub-stage of the microscope can be utilised. With opaque objects it is a matter of indifference, as these must be lit by reflected light by one of the many methods in use for that purpose. If, for instance, it is desired to take a photograph of some sand, in order to show the character of any particular variety, or the nature of it generally, we may proceed as follows: On an ordinary 3 × 1 microscope slip of glass place a little white wax and melt over a bunsen or spirit lamp: this should then be spread evenly, and sprinkled over with the sand, which will be found to adhere well to its surface. Directly the wax is cool—which it does rapidly—a piece of dead black paper is placed upon the underside of the slide, when it is ready for examination in the microscope. The objective used in photographing may be a seventy-five millimetre (three-inch) planar, or similar lens, according to the magnification desired and the camera extension available. After the focusing has been satisfactorily performed, the burning of an inch or two of magnesium ribbon some little distance behind the objective will enable an exposure to be made, although it is better to employ a steady light, and some form of apparatus for concentrating it upon the specimen. No absolute rule can be laid down as to the illumination required, as so much depends upon the object itself and the particular points that it is desired to show most in it. Everyone must therefore exercise his own judgment in the matter; but it must be quite understood that even with low powers the images must be sharp and clear, in order that, if used as lantern slides, no defects shall be apparent when projected upon the screen. With regard to magnification, it often facilitates matters if we determine beforehand some definite linear magnification to make the image, and then, by the use of a formula for obtaining the conjugate foci, to place the focusing screen and the objective, and the latter and object, at the distance indicated, when the image will be practically in focus and of the size desired. Thus, suppose that we determine to make our image sixteen diameters as large as the object, and that a one-hundred-millimetre (four-inch) focus lens is to be used; then by the formula $v=(n+1)\ f$ we can find the distance at which to place the screen; and as the relation between the distance of image and its object from the lens is the same as that of their relative size, we can obtain the distance u at which to place the object from the lens to obtain an increase in size of sixteen diameters, the details of the calculation being as follows:—

follows :— $v=(16+1)\ 4=68$ inches.
and $u=68/16=4{\cdot}25$ inches.

Therefore, if we place the screen and object at these distances from the lens, the image will be approximately sharp, and will only require a little focusing to make it absolutely so. The position for any given magnification having been determined for each or any particular objective, the distance is noted, when by the use of a centimetre or millimetre scale the camera can be set almost instantly for the desired magnification.

PHYSICS.

SIMPLE SPECTROSCOPIC APPARATUS.—Spectrometers and spectrographs of the highest precision, as at present constructed for advanced research work, are necessarily expensive, as all the optical and mechanical parts must be of great perfection to give the required definition and accuracy; but for elementary spectroscopic analysis quite an efficient instrument can be obtained by converting an ordinary photographic camera into a spectrograph, which can be done at comparatively low cost.

Light can be decomposed by the use of either a glass prism or by a diffraction grating. The prism will produce a spectrum of greater light intensity than will the grating, but the spectrum will be abnormal, that is, the violet region will suffer a relatively greater dispersion for the same change in wave-length than the red. The diffraction grating, although giving a normal spectrum, is under the disadvantage that the available light is not all found in one spectrum, but is distributed over spectra of different orders, although often as much as half the light is found in the first order.

The spectrograph, in its simplest form, consists of a slit, collimating lens, prism or grating, and camera, and in simple instruments the camera generally entails the greatest expense. If, therefore, a photographic camera of hand or stand type has an objective of reasonably good definition, it should only be necessary to add the slit, collimating lens, and grating to convert the instrument into an excellent little spectrograph. The simplest method of accomplishing this is to employ, as dispersing system, a grating replica, mounted on a glass prism of the required angle to give approximately direct vision. The spectrum will not be a true grating spectrum, owing to the slight additional dispersion from the compensating prism, and allowance must be made for this when determining wave-lengths. The spectroscopic attachment can be arranged as in Figure 217.

The light passing through the slit, S, is collimated by the small achromatic lens, O, and after entering the dispersing system, P, a sharp spectrum is formed on the plate by means of the photographic lens. The lens, O, is mounted in a sliding tube, with scale, so that the focusing adjustment can be made more conveniently than by moving the photographic lens, especially in the case of hand cameras. The camera must be adjusted, however, so that objects beyond a hundred feet are in focus, or an excessive tilt to the camera back will be required to bring both ends of the spectrum into focus.

A spectrum photograph obtained with such apparatus, constructed by Messrs. Adam Hilger, Ltd., of Camden Road, is reproduced in Figure 218, and is the arc spectrum of iron, with lithium and sodium between wave-lengths seven thousand and three thousand eight hundred. The sodium lines are clearly shown separated on the negative.

Figure 219 is a comparison photograph of the arc spectra of copper and brass. The comparison photographs are obtained by exposing first the lower portion of the slit to the light coming from the unknown sample, and then the upper portion to the light from the standard, by means of a sliding plate with two apertures cut in it, and so arranged that the lower edge of one aperture is exactly in line with the upper edge of the other.

The range of spectrum obtained depends on the nature of the photographic lens employed, but will, with the majority of lenses, extend between wave-lengths eight thousand and three thousand six hundred. From wave-length eight thousand to six thousand, plates sensitive to the red must be used, and a filter must be placed in front of the slit to prevent the violet region of the second order overlapping the red of the first.

The instrument is extremely useful for determining the colour-sensitiveness of photographic plates by the wedge method of Dr. C. E. Mees (see *British Journal of Photography*, 1907). For this purpose, the neutral tint wedge, W (Figure 217) is mounted in front of the slit, and an incandescent gas or Nernst lamp used as light source. Such wedge photographs are shown in Figure 220 (*a* and *b*). *a* indicates the sensitiveness of a plate made sensitive to the red, while *b* indicates an ordinary plate. It will be noticed that both plates are comparatively insensitive at about wave-length four thousand eight hundred.

If in place of the neutral tint wedge there is employed a wedge cell, absorption photographs of dyes can be obtained in the same way. The deviation of the light caused by the liquid prism of dye is compensated for by filling the opposite side of the wedge cell with the solvent.

The spectroscopic attachment, when removed from the camera, can be used as a direct-vision spectroscope of high dispersion.

F. Stanley.

ELECTRICAL NOMENCLATURE.—In a letter in which Mr. Thomas Coats, of Glen Tanar, Aboyne, N.B., advocates a revision of electrical nomenclature, it is suggested that a method of instruction, based upon the real existence of resinous electricity, would be of advantage to students. This kind of electricity he would call positive, and its defect negative. There is much to be said for this view. Who first called vitreous electricity positive and what guided his choice are questions of great historical interest in this connection.

ENLARGING AND REDUCING PHONOGRAPH RECORDS.—The only method so far available for enlarging or reducing phonograph records of the human voice or musical instruments, and thus augmenting or decreasing their sound intensity, was unable to ensure any satisfactory results. The groove traced by the phonograph style being enlarged (or reduced) by means of some pantograph arrangement, that is, by purely mechanical means, the unavoidable vibrations of the apparatus were bound to result in a more or less serious deformation of the original record.

In a paper recently submitted to the French Academy of Sciences, M. G.-A. Le Roy, of Rouen, describes a new process which, by purely physico-chemical means, obtains the same result, thus not only avoiding the above drawback, but affording a possibility of even improving the acoustic qualities of the record.

Whereas the original record is generally taken under conditions of increased sound intensity, and, accordingly, unavoidable disturbing noises, the new process, in fact, enables the original intensity to be reduced to rather moderate limits, any strengthening of sounds being afterwards obtained at will, and without any deformation, by enlarging the initial record. Moreover, the original phonogram, or, indeed, any enlarged reproduction, can be reduced to smaller sound intensity, and, accordingly, to a smaller compass, without any prejudice to its acoustic qualities.

Phonograph records are, according to M. Le Roy's process, enlarged by moulding with a substance capable of swelling, and reduced in size and intensity by moulding with a substance capable of contracting uniformly. It may be briefly described as follows:

Supposing a copper mould to have been obtained by galvanoplastic means from the original record in the wax of a gramophone plate. In order to enlarge this phonogram *a*, a mould is produced by means of a gelatine solution as concentrated as possible (thirty to fifty per cent. of dry gelatine). This gelatine mould, *b*, is placed in cold or slightly tepid water, possibly mixed with two to five per cent. salts, such as alum, and, if desired, acidulated with some acetic acid. As soon as the swelling of the gelatine is completed, the mould is made insoluble—and thus fixed—by dipping it into formolic water, and, after drying, is used in producing a solid matrix in wax, or any other plastic substance, which, in its turn, by galvanoplastic means, supplies the definite copper mould.

By repeating the same process over again, any desired enlargement can be obtained, a single operation supplying an up to three-fold enlargement.

In order, on the other hand, to reduce the original record, a mould is taken with gelatine as diluted as possible (ten to twenty-five per cent.), which is deprived of its water, either by immersion into alcoholic or concentrated aqueous solutions of salts, precipitating gelatine, or by drying in dry air, or in a vacuum. The gelatine mould, thus freed from its water, is used in the same way as above described, in obtaining an intermediate mould of plastical substance, from which the definite copper mould is prepared by galvanoplastical means. While several successive stages will allow any reduction to be obtained, a single operation supplies a linear reduction from 1 to 0·6.

In Figure 221, *a* shows an original record on a disc one hundred and twenty millimetres in diameter; Figure 222 is an enlargement to one hundred and ninety millimetres; and Figure 223, a reduction to eighty millimetres.

ALFRED GRADENWITZ.

ZOÖLOGY.

By PROF. J. ARTHUR THOMSON, M.A., LL.D.

INBREEDING IN RATS.—Dr. G. C. Bassett has found that the closest inbreeding in white rats was followed, after four generations, by a loss in brain-weight of from seven to ten per cent. on the average, and a loss in ability to form habits of about thirty per cent. on the average. But no further important degeneration of the stock occurred, even to the tenth generation of inbreeding.

DARKNESS AND DEPIGMENTATION.—Dr. A. M. Banta has been experimenting on the influence of cave conditions on animals introduced into them. He finds a progressive loss of pigment in mud minnows (*Umbra limi*), a crayfish (*Cambarus bartoni*), some salamander larvae, and a lot of wood-frog larvae. There is an Amphipod *Eucrangonyx gracilis*, an almost pigmentless form of which lives in caves in Central Indiana, while the normally pigmented form is abundant in the surface streams in the same region. It is interesting to find that experiments show the cave form to be less responsive to light and more responsive to tactile stimulation than its outside relative.

CATERPILLAR REARED BY ANTS.—F. Le Cerf reports on a remarkable association between a Lycaenid caterpillar and a colony of ants of the genus *Cremastogaster*. The case was discovered by MM Alluaud and Jeannel on the Kikuyu escarpment. Certain acacias bear numerous nut-like galls, perforated by an orifice about one millimetre in diameter through which the ants go out and in. The caterpillar is about ten millimetres in length, and curiously onisciform or chiton-like. It bears remarkable modified hairs. Its mouth-parts suggest a vegetarian diet, and it probably feeds on the acacia leaves which the ants store. It could not possibly get out of the gall, and it must have been reared there by the ants.

NEW PARASITIC COPEPOD FROM A NOVEL HOST.—There is no end to the strange forms exhibited by parasitic Copepods, and one of the reasons, apparently, is that offshoots from many different non-parasitic Copepod stocks have drifted into parasitism, and that on many different hosts. Mr. G. P. Farran has recently described a new form, *Cholidya polypi*, from the arm-membrane of an Irish Octopus. It is in a way a parasite in the making, for its affinities with *Idya* are still obvious. It thus recalls *Balaenophilus*, which Aurivillius described from another strange habitat—the baleen plates of the blue whale. For *Balaenophilus* is another parasite in the making, with obvious relationship to *Harpacticus*, which is in the same family as *Idya*.

TREE KANGAROOS.—Albertina Carlsson has made an interesting study of *Dendrolagus dorianus*, one of the tree-kangaroos, which differ from the typical members of the family (Macropodidae) in not showing the usually conspicuous disproportion between fore limbs and hind limbs. It sometimes walks on the ground with both hands down, or with only one; it sometimes climbs with its hands gripping the branches. As in other members of the genus, the hairs of the neck are turned forwards, but it is peculiar to this species that the same is true of the hairs of the back. Some zoölogists maintain that all mammals, except Monotremes, have been derived from tree-climbing ancestors; but the anatomical facts in regard to *Dendrolagus* point to its derivation from terrestrial forms, secondarily arboreal

THE FACE OF THE SKY FOR JULY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 28.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°	h. m.	°	h. m.	°
July 2	6 42·4	N 23·1	13 54·1	S. 10·1	8 3·0	N. 18·2	9 10·6	N. 18·2	10 24·0	N. 11·2	21 37·0	S. 15·1	20 53·8	S. 18·2
,, 7	7 3·0	22·7	19 0·2	S. 26·9	7 59·3	17·1	9 34·0	16·3	10 35·1	10·0	21 35·0	15·3	20 53·2	18·2
,, 12	7 23·5	22·1	23 15·3	S. 3·7	7 48·8	16·6	9 56·8	14·2	10 46·2	8·8	21 34·0	15·4	20 52·4	18·3
,, 17	7 43·7	21·3	2 50·2	N 21·9	7 35·2	16·7	10 19·0	12·0	10 57·3	7·6	21 32·1	15·6	20 51·7	18·3
,, 22	8 3·8	20·4	7 34·2	N. 25·4	7 23·7	17·3	10 40·7	9·7	11 8·5	6·4	21 30·0	15·8	20 50·9	18·4
,, 27	8 23·6	N. 19·4	11 58·5	S. 2·2	7 19·5	N. 18·3	11 1·9	N. 7·3	11 19·8	N. 5·2	21 27·7	S. 16·0	20 50·1	S. 18·4

TABLE 29.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
July 2	− 2·4	+3·1	340·6	+19·6	−20·9	+0·3	121·8	55·0	8 40 *m*	8 23 *e*
,, 7	− 0·1	3·6	280·4	− 5·1	20·8	0·3	192·0	87 5	4 35 *e*	9 35 *m*
,, 12	+ 2·2	4·1	214·2	−21·5	20·7	0·3	262·1	119·5	4 50 *m*	6 38 *e*
,, 17	4·4	4·6	148·0	−16·2	20·0	0·3	332·3	151·6	10 36 *e*	7 49 *m*
,, 22	6·6	5·1	81·8	+ 8·1	20·5	0·3	42·5	183·6	10 50 *m*	4 52 *e*
,, 27	+ 8·7	+5·5	15·6	+22·1	−20·3	+0·3	112·7	215·7	6 40 *e*	3 59 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}4$, $9^h\ 55^m{\cdot}6$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN has commenced to move southward. Furthest from Earth $2^d\ 11^h e$. Its semi-diameter increases from 15′ 45″ to 15′ 47″. Sunrise changes from $3^h\ 48^m$ to $4^h\ 23^m$; sunset from $8^h\ 18^m$ to $7^h\ 49^m$. There is no real night early in July.

MERCURY is an evening star till the 16th, when it passes Inferior Conjunction and becomes a morning star. Semi-diameter increases from 5″ to 6″, then diminishes to $4\frac{1}{2}$″. Illumination diminishes from $\frac{1}{3}$ to zero, then increases to $\frac{1}{5}$.

VENUS is an evening star, $\frac{3}{4}$ of disc illuminated. Semi-diameter 7″. The fact of its declination being south of the Sun impairs the conditions of observation for northern observers.

THE MOON.—Full $7^d\ 2^h\ 0^m\ e$. Last Quarter $15^d\ 7^h\ 32^m\ m$. New $23^d\ 2^h\ 38^m\ m$. First Quarter $29^d\ 11^h\ 51^m\ e$. Perigee $3^d\ 8^h\ m$. Apogee $15^d\ 3^h\ e$. Perigee 28^d noon, semi-diameter 16′ 15″, 14′ 48″, 16′ 12″ respectively. Maximum Librations, 4^d 7° N, 9^d 6° W, 19^d 7° S, 21^d 5° E, August 1^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 30).

MARS is advancing through Leo, 1° N. of ρ Leonis on 4th, $\frac{1}{2}$° S. of χ Leonis on 18th. The semi-diameter during July diminishes from 2″·3 to 2″·1. The unilluminated lune is on the East: its width diminishes from $\frac{1}{3}$″ to $\frac{1}{4}$″. The Planet is near Venus at the end of the month.

JUPITER is a morning star in Capricornus, nearing opposition. Polar semi-diameter, 22″.

Configuration of satellites at $0^h\ 30^m\ m$ for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.
July 1	3	○	12	4●	July 17	324	○	1
,, 2	$3{}^{2}_{1}$	○	4		,, 18	13	○	${}^{2}_{4}$
,, 3	32	○	14		,, 19		○	1234
,, 4	1	○	324		,, 20	21	○	34
,, 5		○	1234		,, 21	2	⊙	34
,, 6	2	○	134		,, 22	3	○	124
,, 7	1	○	34	2●	,, 23	31	⊙	4
,, 8	3	○	124		,, 24	32	○	14
,, 9	312	○	4		,, 25	13	○	24
,, 10	$3{}^{2}_{4}$	○	1		,, 26		⊙	123
,, 11	41	○	2	3●	,, 27	412	○	3
,, 12	4	○	123		,, 28	42	○	13
,, 13	42	○	3	1●	,, 29	43	○	12
,, 14	$4{}^{2}_{1}$	○	3		,, 30	431	○	2
,, 15	43	○	12		,, 31	432	○	1
,, 16	${}^{3}_{4}12$	○						

The following satellite phenomena are visible at Greenwich, $1^{d}\ 1^{h}\ 26^{m}\ 12^{s}$ *m*, IV. Oc. R.; $4^{d}\ 0^{h}\ 26^{m}\ 49^{s}$ *m*, III. Oc. R.; $2^{h}\ 49^{m}\ 25^{s}$ *m*, I. Ec. D.; $5^{d}\ 0^{h}\ 1^{m}\ 22^{s}$ *m*, I. Sh. I.; $0^{h}\ 51^{m}\ 58^{s}$ *m*, I. Tr. I.; $2^{h}\ 17^{m}\ 48^{s}$ *m*, I. Sh. E.; $3^{h}\ 8^{m}\ 28^{s}$ *m*, I. Tr. E.; $6^{d}\ 0^{h}\ 27^{m}\ 47^{s}$ *m*, I. Oc. R.; $10^{h}\ 30^{m}\ 17^{s}$ *c*, II. Ec. D.; $7^{d}\ 2^{h}\ 59^{m}\ 4^{s}$ *m*, II. Oc. R.; $8^{d}\ 9^{h}\ 55^{m}\ 36^{s}$ *c*, II. Tr. E.; $9^{d}\ 2^{h}\ 31^{m}\ 2^{s}$ *m*, IV. Sh. E.; $11^{d}\ 3^{h}\ 53^{m}\ 0^{s}$ *m*, III. Oc. R.; $12^{d}\ 1^{h}\ 54^{m}\ 57^{s}$ *m*, I. Sh. I.; $2^{h}\ 37^{m}\ 19^{s}$ *m*, I. Tr. I.; $11^{h}\ 12^{m}\ 22^{s}$ *c*, I. Ec. D.; $13^{d}\ 2^{h}\ 13^{m}\ 25^{s}$ *m*, I. Oc. R.; $10^{h}\ 40^{m}\ 8^{s}$ *c*, I. Sh. E.; $11^{h}\ 20^{m}\ 21^{s}$ *c*, I. Tr. E.; $14^{d}\ 1^{h}\ 4^{m}\ 45^{s}$ *m*, II. Ec. D.; $15^{d}\ 10^{h}\ 57^{m}\ 8^{s}$ *c*, II. Sh. E.; $16^{d}\ 0^{h}\ 14^{m}\ 17^{s}$ *m*, II. Tr. E.; $18^{d}\ 1^{h}\ 14^{m}\ 26^{s}$ *m*, III. Ec. D.; $19^{d}\ 3^{h}\ 48^{m}\ 40^{s}$ *m*, I. Sh. I.; $20^{d}\ 1^{h}\ 6^{m}\ 50^{s}$ *m*. I. Ec. D.; $3^{h}\ 58^{m}\ 19^{s}$ *m*, I. Oc. R.; $10^{h}\ 17^{m}\ 9^{s}$ *c*, I. Sh. I.; $10^{h}\ 48^{m}\ 1^{s}$ *c*, I. Tr. I.; $21^{d}\ 0^{h}\ 34^{m}\ 8^{s}$ *m*, I. Sh. E.; $1^{h}\ 5^{m}\ 1^{s}$ *m*, I. Tr. E.; $3^{h}\ 39^{m}\ 22^{s}$ *m*, II. Ec. D.; $10^{h}\ 24^{m}\ 26^{s}$ *c*, I. Oc. R.; $22^{d}\ 10^{h}\ 38^{m}\ 39^{s}$ *c*, II. Sh. I.; $11^{h}\ 36^{m}\ 8^{s}$ *c*, II. Tr. I.; $23^{d}\ 1^{h}\ 33^{m}\ 59^{s}$ *m*, II. Sh. E.; $2^{h}\ 31^{m}\ 18^{s}$ *m*, II. Tr. E.; $25^{d}\ 8^{h}\ 42^{m}\ 2^{s}$ *c*, IV. Sh. E.; $26^{d}\ 0^{h}\ 34^{m}\ 55^{s}$ *m*, IV. Tr. E.; $27^{d}\ 3^{h}\ 1^{m}\ 23^{s}$ *m*, I. Ec. D.; $28^{d}\ 0^{h}\ 11^{m}\ 4^{s}$ *m*, I. Sh. I.; $0^{h}\ 31^{m}\ 56^{s}$ *m*, I. Tr. I.; $2^{h}\ 28^{m}\ 16^{s}$ *m*, I. Sh. E.; $2^{h}\ 49^{m}\ 6^{s}$ *m*, I. Tr. E.; $9^{h}\ 30^{m}\ 4^{s}$ *c*, I. Ec. D.; $10^{h}\ 43^{m}\ 52^{s}$ *c*, III. Sh. E.; $29^{d}\ 0^{h}\ 3^{m}\ 51^{s}$ *m*, III. Tr. E.; $0^{h}\ 8^{m}\ 36^{s}$ *m*, I. Oc. R.; $8^{h}\ 56^{m}\ 49^{s}$ *c*, I. Sh. E.; $9^{h}\ 15^{m}\ 4^{s}$ *c*, I. Tr. E.; $30^{d}\ 1^{h}\ 15^{m}\ 35^{s}$ *m*, II. Sh. I.; $1^{h}\ 52^{m}\ 0^{s}$ *m*, II. Tr. I.; $4^{h}\ 10^{m}\ 47^{s}$ *m*, II. Sh. E.; $31^{d}\ 10^{h}\ 54^{m}\ 20^{s}$ *c*, II. Oc. R.

The eclipses will take place to the left of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN and NEPTUNE are too near the Sun for convenient observation.

URANUS is a morning star.

COMETS.—See "Notes on Astronomy."

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.		Dec.	Remarks.
	°			
May-30 Aug	333	·	28	Swift, streaks.
May-July ..	252		21	Slow, trains.
June-Aug.	310	·	01	Swift, streaks.
June-Sept. .	335		57	Swift.
June-July	245		64	Swift.
June Aug.	303	·	24	Swift.
July 6-22	284		13	Very slow.
July 15-31	23	+	43	Swift, streaks.
July 19	315	+	48	Swift, short.
July 22 27 .	335	-	51	Swift, streaks.
July-Aug.	308		12	Slow, long.
July 25-Sept. 15	48	·	43	Swift, streaks.
July 28 ...	339	-	11	Slow, long, conspicuous shower, the July Aquarids.
July-Sept. ...	335	+	73	Swift, short.
July 8-31 ...	317	+	31	Swift, white.
July-Aug. ...	280	+	57	Slow, short.
July-October ...	355	+	72	Swift, short.

In the cases where the radiant is stated to be active for several months, there is a difference of opinion as to whether it can be regarded as a single shower or a combination of several.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable (see Table 31).

TABLE 30. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reappearance. Time.	Reappearance. Angle from N. to E.
1914.			h. m.	°	h. m.	°
July 3 ..	Wash. 965	7·2	9 15 *e*	79	—	—
,, 7 ...	Wash. 1220	6·8	0 50 *m*	79	—	—
,, 12 ...	82 Aquarii	6 4	1 11 *m*	88	2 15 *m*	199
,, 13 ...	Wash. 1584	7·3	—	—	1 56 *m*	256
,, 15 ...	Wash. 65	6·9	—	—	0 7 *m*	216
,, 15 ...	Wash. 69	6·6	—	—	1 50 *m*	193
,, 17 ...	μ Arietis	5·7	1 13 *m*	37	2 7 *m*	270

From New to Full disappearances take place at the Dark Limb, from Full to New reäppearances.

TABLE 31. NON-ALGOL STARS.

Star.	Right Ascension	Declination	Magnitudes.	Period.	Date of Maximum
	h. m.	°		d.	
o Herculis	18 4	+28·7	4 1 to 4·4	β Lyrae Star?	
WZ Sagittarii	18 12	−19·1	7 7 to 9·2	21 7	June 30.
W Lyrae	18 12	+36·6	7·3 to 12·5	196½	June 25.
Y Sagittarii ...	18 16	−18·9	5·8 to 6·6	5·7734	
d Serpentis	18 23	−0·1	4·9 to 5 6	irregular.	
R Lyrae	18 53	+43·8	4·2 to 5·1	irregular.	
R Sagittarii	19 12	−19·5	7·0 to 13 0	200	May 11.
AF Cygni	19 28	+46·0	6·9 to 8·0	94	May 22.
RT Aquilae	19 34	+11·5	7 4 to 13 5	325	July 26.
R Cygni	19 35	+50·0	5·9 to 13·8	425·0	April 28.
η Aquilae	19 48	+0·8	3·6 to 4·2	7·1764	
Z Cygni	19 50	+49·8	7·1 to 13·8	263	July 24.

Principal Minima of β Lyrae July $12^{d}\ 5^{h}$ *m*, $25^{d}\ 3^{h}$ *m*.

REVIEWS.

ASTRONOMY.

Fall of a Meteorite in India.—By J. COGGIN BROWN. From the Records of the Geological Survey of India. Volume XLIII. Part 3. Calcutta.

Although actual falls of meteorites, or aërolites, appear to be more commonly witnessed in India than in Europe, yet even in the former country such events are of comparatively rare occurrence, so that each one has a special interest of its own. Such falls are, of course, much more commonly witnessed by natives than by Europeans, and in such cases, if the specimens are to be saved for science, prompt action is essential, as otherwise the villagers who may have seen the fall usually consider it in the light of a supernatural manifestation, and may not infrequently build an inviolable sanctuary over the site where the fragments fall.

A recent event of this nature was recorded in *The Statesman*, Calcutta, of January 18th, 1913, in the following words :—

"A correspondent notes from Mussoorie : On Sunday, the 12th instant, at about 6 p.m., a strange phenomenon occurred, when suddenly the whole place became a blaze of light, which was almost blinding to the eyes. On observers looking up for the cause, they saw a large ball of fiery substance similar to large cannon-balls, travelling from north-west to south-east, throwing out sparks. It suddenly burst with a fearful report, followed by two similar reports, as if cannons were being fired. This was followed up by continual reports, as if a *feu-de-joie* was being fired, which lasted for fully ten seconds."

To the officials of the Geological Survey of India this account at once suggested the fall of a large meteorite, fragments of which might have struck the Earth in the neighbourhood of Dehra Dun and Mussoorie. A communication was consequently made forthwith to the Superintendent of The Dun, requesting that immediate steps might be taken to recover any such fragments. No time was lost, and, as we learn from a report by Mr. J. Coggin Brown, in Volume XLIII, Part 3, of the *Records of the Geological Survey of India*, it was soon ascertained that one Daya Ram, the *Mukhia* of Banswal, a hamlet about ten and a half miles from Mussoorie, had a few pieces of the meteorite carefully wrapped in a cloth in his house. These he was induced by the Sub-Divisional Officer of the district to hand over, and they are now safely housed in the Offices of the Geological Survey of India in Calcutta, where they have been subjected to a chemical analysis, which has proved of considerable interest to mineralogists.

Daya Ram's story, as told to the Sub-Divisional Officer, is as follows : On the evening in question the narrator, on seeing the light and hearing the accompanying reports, stepped hastily outside his house-door, and, while standing there, was immediately made aware of some body falling close behind his ear, and then striking a rock embedded in the ground some five feet distant from the hut. The force of the impact was such that the falling body was shivered into small fragments, one of which struck a wooden vessel about a couple of feet in height of the type commonly used in the hills for carrying oil and other liquids. Procuring a light, as it was too dark to make an effective hunt without one, Daya Ram proceeded to institute a regular search for other fragments. This, however, had to be postponed till the following morning, when a mark was observed on the smitten rock, and several fragments, spread over a distance of about twenty feet, were collected.

It may be added that the fall of this aërolite was witnessed, from a spot near the Grand Central Hotel, Mussoorie, by the Sub-Divisional Officer himself, who heard "a noise as of something large rushing through the air"—an accompaniment of the fall not mentioned in *The Statesman's* account.

R. L.

BOTANY.

British Flowering Plants (Volume I).—By MRS. HENRY PERRIN. 177 pages. 66 coloured plates. 12-in. × 10½-in.

(Bernard Quaritch. Price 15 guineas net for the 4 volumes.

For many years Mrs. Henry Perrin has devoted much of her leisure to making accurate drawings in water colour of British flowering plants, and the book, of which we have received the first volume, is the outcome of a desire that Mrs. Perrin's work should be preserved in some readily accessible form. The drawing which we, by permission, reproduce here (see Plate I, facing this page) of the Marsh Marigold (*Caltha palustris*) will show the artistic merit of the drawings, the care with which the various parts of the plant are illustrated, and the success with which the Menpes Printing and Engraving Company have reproduced the originals in four colours. We should note that this illustration appears in the second volume.

Professor Boulger, who knows how to bring forward his facts in an attractive manner, has written the introduction and the descriptions of the figures, which include a number of drawings of floral dissections. It has only been possible to make a selection of Mrs. Perrin's drawings, or otherwise the book would have run into a very large number of volumes, and the expense of producing it would have been too great. It will be evident, however, to those who know something about the production of plates that not only time and patience, but much money, must have been lavished upon the book. In all, there will be three hundred coloured illustrations, and these have been made as representative as possible. The Grasses and Sedges have been omitted, and some minor families of Water Plants.

Volume I consists of an introduction, already mentioned, which deals with the terms used in describing the leaves, roots, and flowers, which may serve to make more intelligible the notes on the different species ; and it must be said at once that these, as a rule, explain themselves, for Professor Boulger, no doubt realising that many of those who take up the book will do so because they are attracted first of all by its artistic side, has been at considerable pains to explain many terms which he uses as he goes along. The volume deals with Gymnosperms, Monocotyledons, and twelve families of Dicotyledons.

Only a thousand copies of the complete work will be printed. Those who are fortunate enough to obtain one will have something to be proud of, and we confidently advise every lover of flowers whose purse is deep enough to make a point of buying a copy of "British Flowering Plants."

W. M. W.

Physiological Plant Anatomy.—By DR. G. HABERLANDT, translated from the German by MONTAGU DRUMMOND. 777 pages. 291 figures. 9-in. × 6-in.

(Macmillan & Co. Price 25/- net.)

On three occasions Professor Haberlandt has revised his book on plant anatomy, and the present work is a translation of the fourth German edition. The scheme of the book is to consider structure along with function. The whole subject is gone into in great detail, and some idea of this may be gained from the statement that such points as the administrative function of the nucleus, the production of wound cork, the absorption of water by leaves, and the curious structures called eel-trap hairs, developed in connection with the relation of plants and crawling insects, and furnished with special locking devices, are dealt with and described. A very interesting paragraph is that concerned with annual rings. The transverse section of the plank root of *Parkia africana*, which the author brought back with him from Buitenzorg, has a total vertical

THE MARSH MARIGOLD.

(From "British Flowering Plants," by Mrs. Henry Perrin and Professor Boulger.
By the courtesy of Mr. Bernard Quaritch.)

diameter of 140 centimetres, but the organic centre is 92 centimetres distant from the upper surface, and therefore only 12 centimetres from the lower surface of the root. Epinasty, as it is called, is not much in evidence in the zone represented by the first twelve annual rings, which amount in all to 9 centimetres on the upper and 6.5 centimetres on the lower side, but the thirteenth annual ring initiates the subsequent prodigious development of the upper half. Those who are fond of structural botany will find in "Physiological Plant Anatomy" information and material which appeals specially to them, that is not too common in other books on the subject in our language.

W. M. W.

My Garden in Spring.—By E. A. Bowles, M.A. 308 pages. 40 plates. 9-in. × 6-in.

(T. C. & E. C. Jack. Price 5/- net.)

As regards its production, this book is an excellent example of modern printing and illustrating in half-tone and in colour. Its appearance also points to the great interest which is now taken in gardens, and it contains much of value to the would-be horticulturists who read what the author thinks and does. They may not trouble to criticise the style of writing, or be worried by the occasional affectation or attempts at humour which they meet. We feel constrained to point out, however, that "the lunatic asylum" which gives its name to one chapter is not the house in which the author lives, but only a part of the garden where teratological specimens are grown. We are pleased that some visitors to Mr. Bowles's garden have said that it is too much like a museum, because this shows that he grows plants of botanical as well as horticultural interest. We should much like to know, however, why Mr. Reginald Farrer, who contributed the preface, should describe Sir Frank Crisp's rock-garden in such a way that anyone who has been privileged to see it could not fail to recognise it, and at the same time go out of his way to ridicule it.

W. M. W.

CHEMISTRY.

A New Era in Chemistry.—By H. C. Jones. 326 pages. 8½-in. × 6-in.

(Constable & Co. Price 8/6 net.)

The striking development that has taken place in the science of chemistry during the last twenty-five years, beginning with the far-reaching generalisations of van 't Hoff upon the analogy between osmotic pressures in gases and solutions, and the theory of electrolytic dissociation of Arrhenius justify the author's claim that a new epoch began in 1887. Prior to that time chemistry was still, to a large extent, the storehouse of many isolated facts and observations which required the use of several keys before they could be placed in their proper compartments. To quote Professor Jones's description, chemistry was then passing through the stage of systematisation, and had not yet become a science.

In this book we have a readable account of the more important developments during this period, and the author not only summarises the results of the work, to which he himself has been an important contributor, but also gives us intimate glimpses, at first hand, of the personalities of many of the men who have done the work.

The last chapter deals with our present knowledge of the electrons and radio-chemistry, and it is interesting to note that Professor Jones apparently concurs with the view, expressed many years ago by Ostwald, that energy is what we know, and that the existence of matter is purely hypothetical. Upon the question of the transmutation of the elements, under the influence of radio-activity he suspends judgment.

This is a book to read, not once, but many times, for it is full of interest for the chemist, and for all who have even a slight knowledge of chemistry. There is a good index, but the book would gain in value as a work of reference by the addition of a classified bibliography. C.A.M.

Physical Chemistry and Scientific Thought.—By W. C. McC. Lewis, M.A., D.Sc. 20 pages. 8½-in. × 5½-in.

(Liverpool: The University Press. Price 1/- net.)

This booklet contains Professor Lewis's inaugural lecture, delivered at the University of Liverpool on Friday, January 16th, 1914. The major portion of the lecture is concerned with the question of the nature of Science. Professor Lewis regards Science as a particular branch of Philosophy, and deprecates the view that Science and Philosophy are sharply distinguished from, and, in a manner, opposed to, each other. As he says, the primary object of any science is generalisation, and, so far as Chemistry and Physics are concerned, what is meant by the explanation of any phenomenon is its re-statement in terms of mechanics. Concerning this he writes: "By re-statement I do not mean the mere use of alternative terms, but rather the demonstration that the existence of the phenomenon is to be anticipated on the basis of a series of logical mechanical theorems (which we have reason for regarding as true), often with the addition of something which we find necessary as a connecting link, and to which we give the name of assumption, or hypothesis." The force of the word "logical" in the above statement is not, I think, quite obvious. The theorems of mechanics are just as much inductive laws as those of the other sciences, and carry no logical or *a priori* necessity. But Professor Lewis, on the other hand, definitely repudiates the narrow materialism of the past century. He closes his lecture with some interesting and instructive observations on scientific research, which should be read by those who feel called to a life devoted to the quest of knowledge of Nature.

H. S. Redgrove.

GEOLOGY.

Textbook of Palaeontology, Volume I.—Edited by C. R. Eastman, M.A., Ph.D., adapted from the German of Karl A. von Zittel. Second Edition. 839 pages. 1600 illustrations. 9-in. × 6-in.

(Macmillan & Co. Price 25/- net.)

The second edition of Professor C. R. Eastman's textbook, adapted from the German of von Zittel, is naturally much larger than the first edition published in 1900. It has 839 pages, as compared with 706, and 1600 illustrations, as against 1476 in the old edition. There is also a much longer list of collaborators, amongst which only the names of J. M. Clarke, W. H. Dall, and C. Schuchert appear in the 1900 list. There are naturally, therefore, considerable differences of treatment of the several phyla as compared with the 1900 edition; differences, however, which reflect the great advances of the intervening thirteen years. Parts of the work have been entirely rewritten and rearranged, and the classification in many groups has been completely altered. The book can hardly, therefore, still be regarded as von Zittel's textbook, although in scope and style it is broad-based upon Zittel's great foundation. It is still emphatically a textbook for the advanced student, and we should have welcomed, whilst acknowledging the value of the general introductory chapter, a section on methods of research and on the troublesome questions of nomenclature and priority. One can hardly do enough justice to the beauty of the illustrations and the general production of the book. It has been done with extraordinary care and thoroughness.

G. W. T.

The Birmingham Country: Its Geology and Physiography.—By C. Lapworth, F.R.S. 53 pages. 2 maps. 8¼-in. × 5½-in.

(Birmingham: Cornish Bros. Price 1/-. With maps, price 2/6.)

This little book has had two precursors, one written for a previous visit of the British Association to Birmingham, in 1886, and the other for an excursion of the Geologists' Association in 1898. It is reprinted from the handbook published for the Birmingham Meeting of the British

Association in 1913, and, as might be expected from the retired Professor of Geology at Birmingham University, it is a most complete, readable, and up-to-date account of the geology of an interesting district. The Birmingham country is described as a "sea of Triassic deposits, which fill up to one general level the hollows in a most irregular basin, or old land-surface, carved out of Palaeozoic rocks." The stratigraphy, whilst constituting the major portion of the work, is supplemented by sections on the physiography, tectonics, glaciology, and geomorphology of the area. The value of the book is greatly increased by two excellent maps—one geological, the other topographical—on the scale of two miles to the inch, and covering an area of two thousand five hundred square miles. There is also a bibliography of the more important geological works on the Birmingham district. The geologist coming fresh to the Midlands could not have a better introduction than Professor Lapworth's comprehensive and well-printed book.

G. W. T.

Guide to the Geology of the Whitby District. By LIONEL WALMSLEY. 37 pages. Illustrated. $6\frac{1}{2}$-in. × $4\frac{1}{4}$-in.

(Whitby: Horne & Son. Price 1/- net.)

This is a smaller and less ambitious work on areal geology than Professor Lapworth's, reviewed above. Its title is slightly misleading, since only the coast sections are described, and no attempt is made to deal with aspects other than stratigraphical and palaeontological. The coast is treated in five sections, which comprise a popular account of the rocks and the fossils they contain, with many valuable hints as to their discovery and method of collection. Many of the common fossils are illustrated usefully, if somewhat crudely, and a sketch-map of the Liassic zones in Robin Hood's Bay is inserted. There are one or two misprints and grammatical slips, and a reference to rhombohedral pyrites (page 28), which should be revised in any future edition. Also, the printer has made a hash of the chemical formulae on page 25. The geological visitor to the beautiful and interesting Whitby coast will find the local information given by this little guide distinctly useful for fossil-hunting, and for making a first survey of the geology.

G. W. T.

ORNITHOLOGY.

The Wonders of Bird Life.—By W. PERCIVAL WESTELL. 128 pages. 24 Figures. $7\frac{1}{2}$-in. × 5-in.)

(Manchester: Milner & Co. Price 1/- net.)

Mr. Percival Westell has studied birds for many years, and he has put together in a small compass many interesting points with regard to these creatures, chiefly, we imagine, for the benefit of beginners and for young people; for he tells how to study birds, touches lightly on their flight, wonders of migration, methods of protection, and economic importance. What is more, he indicates how much still needs to be found out, while he offers advice on the putting up of nesting-boxes, and on the study of birds in school grounds and gardens. A chapter dealing with "Bird Names," by the late Dr. W. T. Greene, brings to a close a book which ought to do a great deal of good.

W. M. W.

ZOÖLOGY.

Report on a Zoölogical Mission to India in 1913.—By CAPTAIN S. S. FLOWER. 100 pages. 12 plates. $9\frac{1}{4}$-in. × $6\frac{1}{2}$-in.

(Cairo: Government Press. Price 5/-.)

Captain Stanley Flower last year paid a visit to India, in order to see the various Zoölogical Gardens belonging to Maharajas, the Government, and different municipalities. He collected together much information of particular value to those in charge of collections of living animals, and also to zoölogists in general. These notes he has published in a report, which we commend to our readers. It contains notes on the sizes of elephants, on the colour of their eyes, and on the details with regard to Indian crocodiles. The great tank, seventy-two acres in extent, built near Ahmedabad by the king of that place in the year 1452, is of special interest owing to the island in it, which is laid out as a garden, and forms a sanctuary for birds, which are remarkably tame, and show little fear of mankind. Another point of interest is the enclosure built by the late Maharaja of Alwar, circular in plan, and so arranged that the tigers which are kept in it appear to be at liberty as one approaches it when driving into the palace or walking in the park. Captain Flower also deals with administration and some museums. The plates include interesting pictures of giraffes, elephants, and tapirs.

W. M. W.

GIRDLING THE EARTH WITH SOLAR OBSERVATORIES.

By MARY PROCTOR.

(*Daughter of the late R. A. Proctor.*)

THROUGH the munificence of Mr. Thomas Cawthron, of Nelson, N.Z., who is giving £50,000 for the purpose of building, equipping, and endowing a Solar Observatory in Nelson, another link will be made in the chain of such observatories girdling the Earth. This is a project of vast importance, since it will enable men of science to keep the Sun under continuous observation for the whole twenty-four hours. Rapid changes are constantly taking place on the surface of the Sun, such as vast upheavals and disturbances in the spot-centres known as sunspots. Moreover, a curious connection between sunspots and the Earth has been detected, especially with regard to magnetic storms. As the central body of the solar system, controlling the motions of the planets, and making life possible upon the Earth, the Sun is well worthy of careful investigation.

According to Professor G. E. Hale, Director of the Solar Physics Observatory at Mount Wilson, California, "a permanent decrease of one hundred degrees (about 0·6 per cent.) in the effective temperature of the Sun is considered by good authorities to be sufficient to produce another Ice Age on the Earth. So great a change could hardly occur; but smaller variations due to internal causes, or to modifications in the absorbing power of the Sun's atmosphere, are very probable. Since solar phenomena follow more or less definite cycles of change, a better understanding of them might conceivably permit variations in its radiating power, sufficient to determine seasons of good or bad harvest, to be in some degree anticipated. The importance of solar research from this standpoint is thus sufficiently obvious."

According to observations made by St. John at Mount Wilson, the region in the lower atmosphere of the Sun, including the lowest levels of the reversing layer, and especially the underlying gases, is the region of tremendous disturbances in which the upper portion of the sunspot vortex is located, in which occurs the outflow of material from the interior of the Sun. Above this turbulent region, yet more or less involved in its activities, is the general reversing layer, whose normal condition seems to be one approaching more nearly a stable state. The chromosphere seems quite sharply distinguished from this region, both in its composition and in the movements of its constituent gases near spots.

In the case of storms in the solar atmosphere the point of observation is from the outside, and the upper movements are those directly detected. In the case of terrestrial cyclonic storms but little is known from direct observation of the atmospheric movements over the centre of the storm. Therefore, by means of a chain of solar observatories around the Earth, it would be interesting if our knowledge of cyclonic storms here could be supplemented by continuous observations of such storms on the Sun.

NOTICES.

THE LARVAL EEL.—Mr. Hugh M. Smith, the United States Commissioner of Fish and Fisheries, contributes to *The Guide to Nature* (the organ of the Agassiz Association) an interesting article entitled "The Mysterious Life of the Common Eel."

SCIENTIFIC MEETINGS OF THE ZOÖLOGICAL SOCIETY.—As a result of a post-card ballot, it has been decided that in the new session beginning in October, 1914, the meetings for scientific business shall be held in the afternoons of Tuesdays at 5.30 p.m.

SUCCESS IN PHOTOGRAPHY.—A pamphlet entitled "Simplicity and Success in Photography," which Messrs. Burroughs Wellcome, of Snow Hill Buildings, E.C., will send gratis on request, contains a photograph of Captain Scott's ship, the "Terra Nova," developed by Mr. H. G. Ponting in the Antarctic with tabloid Rytol Universal Developer.

OXFORD UNIVERSITY OBSERVATORY.—The thirty-ninth annual report of the Savilian Professor of Astronomy to the visitors of the University Observatory for 1913-14 contains a list of the names of the Staff and a detailed account of the teaching and research work done, as well as the publications issued.

"PROBLEMS OF SCIENCE."—The Open Court Company, of 149, Strand, have nearly ready for publication an English version of "Problems of Science," by Federigo Enriques, Professor in the University of Bologna. This authorised translation has been made by Katherine Royce, while Professor Josiah Royce, of Harvard University, has contributed an Introduction.

THE BINOCULAR MICROSCOPE.—We are sorry that in our last issue, owing to a slip of the pen, we were far from doing justice to Mr. Leitz's new binocular microscope. What we said was that the microscope was capable of being used for all purposes to which the "binocular" is put. We should, of course, have said "*monocular*," which is a very different thing.

THE EAST AND WEST UNION.—At the International Club on May 22nd an Association was established, under the title of "The East and West Union," for the promotion of cordial relations among the divisions of mankind, without regard to race, colour, or creed, and in particular to encourage a good understanding between East and West. The address of the Provisional Secretary is 59, Egerton Gardens, S.W.

THE ZOÖLOGICAL SOCIETY OF SCOTLAND.—The first annual report of the Zoölogical Society of Scotland gives a brief account of the successful inauguration of the Society and of its Zoölogical Park. We learn that there are four honorary fellows, three hundred and sixty-two life fellows, one thousand eight hundred and eighty-eight ordinary fellows, and six corresponding members. The report contains details as to the animals presented to the Society, and is illustrated by some excellent photographs.

ORNITHOLOGICAL BOOKS.—The sixty-sixth catalogue in Messrs. John Wheldon and Company's new series contains details of more than fourteen hundred books and papers, both old and new, dealing with birds. Some of the books date from the sixteenth century, and come under the heading of "General Systems." The works are well classified according to their subjects, and include illustrated monographs and contributions to a knowledge of classification, morphology, birds of various parts of the world, as well as of species which are kept in captivity.

FALMOUTH OBSERVATORY.—The report of the Observatory Committee of the Royal Cornwall Polytechnic Society for the year 1913 shows that modifications have been recently introduced in the work with a view to the Observatory contributing to the data required in the study of the weather by the Meteorological Office. Tables are given showing the declination of the magnetic needle, sea temperatures, air temperatures, details of sunshine, hydrometric conditions of the air, direction and the velocity of the wind, and the amount of rain.

ADDITIONS TO THE ZOÖLOGICAL SOCIETY'S MENAGERIE.—Among the more important additions to the Zoölogical Society's collection made in April were two elephant seals from the Duke of Bedford, two Indian elephants from *The Daily Mirror*, and two tigers from Major Bigg Withers. A collection presented by Mr. W. K. Pomeroy from Colombia contained two white-browed hares and a pileated heron new to the collection. Mr. Wilfred Smithers contributed two other animals from Argentina, not previously seen at Regent's Park, namely a Merrem's Xenodon and a Neuwied's Viper.

POPULAR ASTRONOMY.—Messrs. G. P. Putnam's Sons announce the immediate publication of "The Essence of Astronomy," by Edward W. Price, which is a popular book telling the things everyone should know about the Sun, Moon, and Stars. It answers in untechnical language the everyday questions of everyday people, the material being so arranged that it is available for quick reference, as well as for interesting consecutive reading. There are many illustrations, while the drawings of Mars are those most recently published, having been made by Professor Lowell in January of this year.

LIVINGSTONE COLLEGE.—Dr. C. Wigram has been appointed to succeed Dr. Charles F. Harford as Principal of Livingstone College. Dr. Wigram is the youngest son of the late Prebendary Wigram, formerly Honorary Secretary of the Church Missionary Society. He was educated at Harrow School, Trinity College Cambridge, and St. Thomas's Hospital, and he is a graduate in Medicine and Arts of the University of Cambridge. He was formerly a Medical Missionary at Peshawar, on the north-west frontier of India, under the Church Missionary Society, and has thus had practical experience of missionary life abroad. He has been for five years on the staff of Livingstone College, first as Resident Tutor, and then as Vice-Principal.

CONCRETE AND CONSTRUCTIONAL ENGINEERING.—The question of the proposed changes in the Concrete Institute is again dealt with in the May number of *Concrete and Constructional Engineering* in its editorial columns. Among the illustrated articles will be found a description of the application of reïnforced concrete in the construction of the Usher Hall, Edinburgh. The new offices of the Metropolitan Railway Company are also described and illustrated, as is also a new building for the port of Para. There is also an article, from the pen of Mr. Chas. F. Marsh, M.Inst.C.E., on "Shearing and Diagonal Tension Reïnforcement in Beams." The question of Electrolysis in Concrete is referred to, and the number contains an article on Lighthouse Construction.

THE ALCHEMICAL SOCIETY.—At a meeting of the Alchemical Society, held at the International Club for Psychical Research, on Friday night, Dr. Elizabeth Severn gave a very interesting address upon "Some Mystical Aspects of Alchemy," in the course of which she said if at any time the secret of transmuting base metals into gold were ever known, it was quite certain that it was not now. Even if discovered at the present day, it was doubtful whether it would be of any benefit to mankind. If everybody knew the secret they would find time for nothing else but turning base metal into gold. The mystic aspect of the question was, she thought, the practical one, although it sounded something like a paradox.

THE ROYAL INSTITUTION.—On Tuesday, June 2nd, at three o'clock, Professor A. Fowler will begin a course of two lectures at the Royal Institution on "Celestial Spectroscopy"; on Thursday, June 4th, Professor Silvanus P. Thompson delivers the first of two lectures on "Faraday and the Foundations of Electrical Engineering"; and on Saturday, June 6th, Mr. Sigismund Goetze will commence a course of two lectures on "Studies on Expression in Art." The Friday evening discourse on June 5th will be delivered by Professor William H. Bragg, on "X-rays and Crystalline Structure," and on June 12th, by Dr. Walter Hines Page (the American Ambassador), on "Some Aspects of the American Democracy." The Institution has recently issued a statement as to the advantages which it offers to its members, and an illustrated pamphlet dealing with its nature and objects. These can be obtained, by anyone interested, from the Secretary at Albemarle Street.

MICROSCOPES and ACCESSORIES.—We have received from Messrs. Angus & Co., who are the depôt agents for Mr. C. Reichert, of Vienna, an abridged catalogue of microscopes and accessory apparatus made by that celebrated Continental firm. A prefatory note calls attention to the fact that since the founding of the firm in 1876 fifty-five thousand microscopes have been produced and sold by it. We have had some experience of objectives made by Mr. Reichert, and we commend them to the attention of our readers. There is a number of useful accessories, such as a breath screen (for keeping moisture from the stand) and an attachable mechanical stage, which call for attention. The comparison eyepiece for bringing two specimens under different microscopes into juxtaposition in the same field of view should prove of considerable usefulness. Special attention is also given in the catalogue to haematological apparatus and to the latest types of microtomes.

THE INSTITUTE OF METALS, MAY LECTURE.—The annual May Lecture of the Institute of Metals was delivered by Professor E. Heyn, of Berlin, on Tuesday, May 12th.

Professor Heyn said that few persons were conscious of the enormous amount of thought bestowed on the question of soundness of materials by thousands of men fighting continuous struggles against the numerous hidden dangers involved in the intricacy of structural material, and working strenuously towards its perfection and reliability.

Certain structural members might fail even without being subjected to stresses in service. For instance, it had often been observed that condenser tubes made out of brass cracked when simply stored up in the yard. Some articles made out of this metal, when exposed to atmospheric influences, underwent an alteration to such an extent that they might be crumbled between the fingers. Similar phenomena could be stated in structural members made out of other metals and alloys when they were manufactured under unfavourable conditions, which lead to serious internal strains.

The lecturer said that he had made a special study of the phenomena connected with internal strains, and then discussed the means for removing or diminishing them.

METEOROLOGICAL CONFERENCE.—Upon the invitation of the Scottish Meteorological Society, it is proposed to hold a Conference of Observers and Students of Meteorology and Allied Subjects in Edinburgh from Tuesday, the 8th, to September 13th, 1914. According to the provisional programme, the proceedings will open with a Presidential Address at 10 a.m. on Tuesday, September 8th. The mornings will be devoted to the discussion of scientific subjects connected with the study of the atmosphere. The afternoons will be available for demonstrations; lectures are to be arranged for two evenings, and perhaps a reception for another. On the Saturday there will be excursions to places of scientific interest. The scope of the papers to be discussed will, it is hoped, include the physical and observational aspects of Meteorology, Climatology, Oceanography, Limnology, Atmospheric Electricity, Terrestrial Magnetism, and Seismology. One of the objects of the Conference will be to bring together observers in these departments of science and those who are interested, from the theoretical point of view, in the discussion of the observations. Special attention will be given to the teaching of Meteorology in schools, and to the relation of Meteorology to Aviation. An exhibition of historical and modern instruments is to be organised. To meet the necessary expenses the subscription for members of the Conference has been fixed at ten shillings. Tickets of admission for ladies accompanying members are to be issued at five shillings. Matriculated students of any university will be admitted as associate members on payment of five shillings. All communications should be addressed to the Honorary Secretary, Edinburgh Conference, Meteorological Office, South Kensington, S.W.

A GIGANTIC LENS.—Messrs. J. H. Dallmeyer have successfully accomplished the task of making a lens of similar character to that of their patent portrait lens, but eleven inches in diameter, with an aperture of $f/4{\cdot}2$. The completed lens is twenty and a half inches long; its width is twelve and a half inches, with a flange diameter of sixteen inches; while it weighs just over one hundred and twelve pounds. It has been made for the use of a photographer in Egypt, who wishes to secure life-sized pictures in natural perspective. The theoretical design presented considerable difficulties, as the standard of definition in the final picture requires to be of as high an order as in the case of a small lens. Aberrations, which increase as the focal length increases, have therefore to be remarkably well corrected, no easy task with a lens of this size. As the diameter far exceeds the separation of the eyes, it was thought that it might be of interest to see what stereoscopic effect could be obtained. A test object was prepared as follows: A thin plate was painted on each side with alternate bands of black and white, arranged so that a black band on the right-hand side corresponded with a white band on the left-hand side. The object was put up about twenty feet from the lens and photographed in four ways: (1) With the lens covered up, except for a small hole in the middle; (2) with the lens covered up, except for a small hole on the right-hand side; (3) with the lens covered up, except for a small hole on the left-hand side; (4) with the complete lens uncovered. The first result corresponds with a photograph taken with a lens of the same focal length, but small aperture, and Numbers 2 and 3 to photographs taken by shifting such a lens five inches to the right and left respectively. The last is similar to what one might expect to see in a stereoscope using both these photographs. In Number 1 there is the end-on view of the plate only; in Number 2 there is the end-on view and also the right-hand side; in Number 3 there is the end-on view and also the left-hand side; in Number 4 there is the end-on view and both sides, the whole thing being combined to form one view. The photographs thus show the ability of a large lens to see round corners. Photographers have often stated that a large lens gives more roundness and modelling in portraiture, and this perhaps is explained by the property of seeing round corners.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

JULY, 1914.

VARIABLE STARS.

By JOHN L. HAUGHTON, M.Sc.

(*Continued from page 219.*)

SHORT-PERIOD VARIABLES.

Excluding cluster variables, there are eighty stars whose light is known to vary in a period of less than one month: of these, seventy complete their cycle in less than ten days, and sixteen in a few hours. Nearly all these stars are Sirian or Solar in spectral type, and generally the period is kept with high regularity.

1. ECLIPSING VARIABLES.

These stars, which are often known as Algols, from the best known of the group, are the only class of variable stars that are not, to a greater or less extent, "wrapped in mystery." They have been carefully studied by many competent observers, and not only has their *modus operandi* been made tolerably clear, but they have served to throw light on other problems. They may be divided into three classes :—

1. Those in which the eclipsing body is quite dark.
2. Those in which it is very faint.
3. Those in which both bodies are of approximately equal brightness.

This third division, however, is probably equally applicable to many Geminid variables, of which more anon. In these cases the classification overlaps.

Figure 226 shows a few typical light-curves of Algol variables. They are from a paper read by A. W. Roberts before the South African Association for the Advancement of Science in 1903.

In Curve No. 1 he explains the constant light-value at the minimum by assuming that the eclipsing body is not quite dark, but that it completely covers the bright star during the minimum, which lasts for about six hours (see Figure 227, Curve 2). Miss Clerke works out that, if this be so, the bright body must be twenty times denser than its dark satellite, which seems very unlikely. A further objection is that there is no observed loss of light when the supposed faintly luminous satellite is eclipsed. From an examination of the light-curve it would appear—assuming this theory—that the two bodies together give four times as much light as the fainter one ; therefore one gives out three times as much light as the other. For the curve to be that shown in the figure, the fainter star must have twice the diameter of the bright component, *i.e.*, must have four times its apparent area. Then when the bright star is eclipsing the darker one, one-fourth of its light, or one-sixteenth of the total light, will be cut off, and there will be a second dip in the light-curve. This has not been observed (see Figure 227).

Another explanation of the phenomenon is that the eclipsing body is quite dark and smaller than the bright star, and that it makes a more or less central transit over the latter. When ingress was complete the amount of light not eclipsed would remain constant until egress commenced. In this

case the areas of the dark and bright bodies would have to be as 3 : 4; and, although the absence of a second minimum would be accounted for, a more serious difficulty is introduced. On plotting the light-curve that would be obtained from such a system, Figure 227, Curve 3 was arrived at : from this it will be observed that the fall of light obtained is much too gradual ; hence this explanation fails. The following analogy may, however, throw some light on the subject. It is well known that in the case of a total eclipse of the Moon this body never becomes quite dark : the usual explanation is that the Earth's atmosphere refracts a considerable amount of sunlight, and throws it on to the Moon. Thus an observer placed on our satellite would never see the sunlight totally extinguished. If we imagine the dark body in the system we have just been considering to be surrounded by an atmosphere, it is quite conceivable that, though it occulted the bright body completely, yet its atmosphere would refract a sufficient amount of the light passing through it to render it visible to us. The only difficulty appears to be in the amount of light refracted—one-quarter of the whole. But when we remember the size of the body with which we are dealing, it will appear likely that it would have a very dense and far-extending atmosphere, which would enable it to collect an enormous amount of light.

Returning to Figure 226, Curve No. 2 is that of a totally dark star partly eclipsing a bright one. This is similar to the light-curve of Algol, except that in the latter case the minima are rounded off instead of showing a sharp cusp. This cusp is a feature that requires some explanation, but none appears to be forthcoming.

Curve No. 3 shows a similar pointed depression, but in this case the second minimum tells us at once that we are dealing with two light-giving bodies; and if the darker one just, and only just, completely eclipsed the other one, it would give such a light-curve.

The star which gives its name to this class, Algol, is exceedingly regular in the ebb and flow of its light. Between 1790 and 1880 the period shortened by eight seconds, and then it commenced to lengthen once more. This may be due to the pair revolving round a third dark body, or to a rotation in the axis of the orbits. It is a characteristic of many eclipsing stars, and Professor H. H. Turner has found that there is a relationship between the period of eclipse and the larger period of change of period. In this connection a quotation from his Presidential Address to Section A of the British Association in 1911 is so clear and to the point that it cannot be omitted. He says :—

"The history of variable-star observation affords us many lessons as to the desirability of simply accumulating observations and letting them speak for themselves, instead of being guided by a theory or hypothesis. . . .

"The late N. R. Pogson made a series of excellent observations on the star R Ursae Majoris in the years 1853 to 1860 ; he then seems to have formulated a particularly unfortunate hypothesis, viz., that he knew all about the variation, and he accordingly only made sporadic observations in succeeding years. Now this star, along with many others, varies in a manner which may be illustrated by the occurrence of a sunrise.

"The average interval between two sunrises is exactly twenty-four hours, but this is only the average. In March the Sun is rising two minutes earlier each day, and the interval is therefore two minutes short of twenty-four hours ; as the year advances the daily gain slackens, and at midsummer the interval is exactly twenty-four hours ; then the Sun begins to rise *later* each day, and the interval exceeds twenty-four hours, and so on, so that there is a regular yearly swing backwards and forwards through a mean value, and, as in the case of all such swings, there is a sensible halt at the extreme values. Now, when Pogson made his observations of R Ursae Majoris in 1853–60, it was at the time of halt at an extreme ; the period remained stationary, and the variation repeated itself eleven times in a closely similar fashion, so that Pogson concluded it would continue in the same way. How many instances suffice for an induction ? Many inductions have been made on fewer than eleven. Unfortunately, the period was just beginning to change, and we lost much valuable information ; for no one else repaired Pogson's neglect adequately ; and the whole swing of the period occupies about forty years, so that the opportunity to study the changes he missed has only quite recently returned."

Another irregularity occurs in some Algols, that is, that the variation of the magnitude sometimes exceeds its normal range. For example, S Cancri generally varies between 8·2 and 9·8, but on April 14th, 1882, it was of the 12th magnitude. No explanation has been given of this.

Concerning the spectra of these interesting bodies, it may be noted that they are all Helium or Sirian stars ; most other short-period variables are solar. Another remarkable fact is that they lie along a great circle nearly coincident with the medial plane of the Galaxy.

2. Non-Eclipsing Variables.

(i) Geminids.

Returning to Figure 226, Curves 4 and 5 are probably those of *Geminid variables*. These are a rather unsatisfactory group of stars, as they include true eclipsing bodies, in which the components are of approximately equal brightness, as well as variables which do not eclipse. In other words, all variables whose light-changes can be represented by a symmetrical, even curve, with the minima midway between the maxima, are classed as Geminids, even though in certain cases the spectroscope shows us that the relative motion of the two bodies to the Earth is nil when the minimum

occurs, while in other cases one body is approaching and the other receding at minimum. The first case, of course, represents an eclipse, while the second cannot. In the former case difference in brightness of the two bodies would account for secondary minima, such as are found in the case of β Lyrae, V Puppis, and many other stars (see Figure 228).

Sir Norman Lockyer's meteoric hypothesis will explain both these types of variation. If we imagine a swarm of meteors, with a second similar swarm revolving in an eccentric orbit round the first, the collisions between individual meteorites will be much more frequent when the planet swarm is in periastron than when it is in apastron. The light of the star being derived from these collisions, the brightness will wax and wane regularly; and, as the minimum will be visible from any point in space at the same time, it may well happen that in some cases we see it when the stars have a rapid end-on motion, relative to us, instead of when that motion is nil, as must be the case in true eclipsing variables. Two planetary swarms will, if the "year" of one be twice that of the other, give rise to a curve of the β Lyrae type.

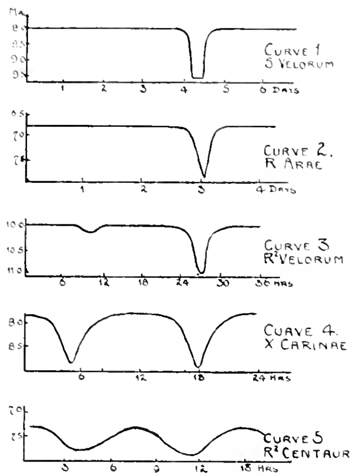


Figure 226. Light-curves of Eclipsing Stars.

(ii) δ Cephids.

We now come to the first well-defined class of non-eclipsing short-period variables, those known as δ Cephids.

The distinguishing features of this type of variable are given in an article in a recent number of *Popular Astronomy*, as follows:—

(1) The variation in the light is continuous.
(2) The extent of the variation is about one magnitude.
(3) The period is short.
(4) The light-curves are symmetrical with a tendency to halt in the descent.
(5) The stars are of approximately solar type.
(6) They are small-orbit binaries with only one bright component.
(7) The light and velocity curves correspond in phase, shape, and period.
(8) The stars do not eclipse; the orbits may be at any inclination to the visual plane.
(9) A shifting in the maximum energy point in the spectrum accompanies the light-change, and there are also variations in the positions of the lines not due to orbital motion.

This appears to be a formidable list of qualifications to be possessed by a star before it can be admitted to the rank of a δ Cephid, and yet we find that many such stars exist.

Figure 229 shows the light-curve of the star which gives its name to this subdivision.

Many theories have been brought forward to account for these bodies. As a well-known writer on astronomy says: "The track of recent astronomical progress is strewn with the dilapidated remnants of hypotheses invented to explain the strange phenomena of stellar variability." Only a few of these hypotheses can be considered here.

A. W. Roberts suggested that the variation was due to the faint star receiving more heat from the bright one when in periastron, and thus getting brighter. Clause 6 in the above charter rules this explanation out of court.

L. A. Eddie suggested that the variation was due to tidal disturbance. Professor Campbell, of Lick Observatory, developed this theory, suggesting a tidal disturbance in the atmosphere of the bright star, due to the gravitative effect of the dark one; but no general relationship has been found between times of maximum brilliancy and times of periastron passage; and, further, the theory does not explain the relation between the maximum light and the maximum velocity of approach.

Curtis assumes that the star is moving in a resisting medium. This makes the front of the star brighter.

Lund, of Colorado College, also suggests a resisting medium, assuming a dark primary at rest relative to the medium, and the bright satellite so close that tidal effects make the periods of revolution and rotation nearly equal. This will cause the heated area to be unsymmetrical; hence a rapid rise and slow decline.

Professor Duncan proves that, for this to be true, (1) the diameter must be greater than the Sun, or (2) the density must be several times that of the Sun; (3) the temperature or intrinsic radiating power must be much less than that of the Sun. He states that the first is impossible, and the second and third are not likely, as the spectrum is solar. He assumes the bright star to be surrounded by an absorbing atmosphere. A rare nebulous atmosphere, like the Sun's corona, surrounds the dark star; and, as it rotates, this brushes aside some of the atmosphere of the bright star, so that it is less deep, and therefore more light comes through on the front side. For this reason the maximum light occurs near the time of maximum positive velocity. It has been observed that the logarithm of the light is proportional to the radial velocity, and, for a medium of uniform denseness, the logarithm of the light is proportional to the thickness; hence the radial velocity is proportional to the thickness. The existence of such an absorbing atmosphere

is well known in the Sun, where Langley has shown that it absorbs from one-half to four-fifths of the light given out. Halving the thickness of such a layer should give a change of 0·8 magnitude. However, the assumption that such an atmosphere is of uniform density seems to be a very big pill to swallow.

Among δ Cephid variables may be mentioned Polaris. This is a recent discovery, and is rather important, as this star had been used as a standard against which to measure the magnitude of others.

curve (see Figure 230). The rise to maximum is very swift, the fall is much slower, and there is a considerable halt at the minimum. Five hundred of these objects have been observed in the Magellanic Clouds and one hundred and twenty-eight in the cluster known as ω Centauri.

Another variety of variable stars, which is not included as a separate division in Pickering's classification, but which nevertheless merits close observation, is to be found in many double stars. Space forbids us to do more than mention in passing

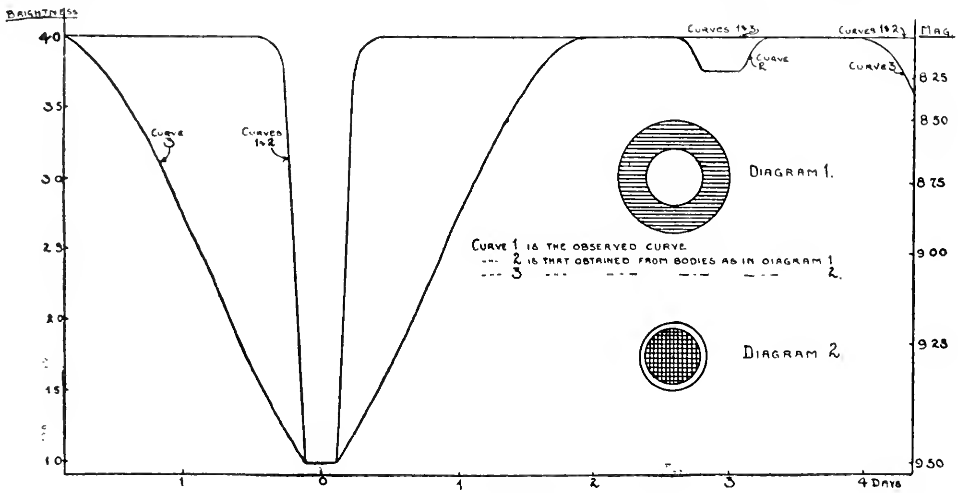


FIGURE 227. S Velorum.

The period is said to be 3·96 days, and the magnitude range 0·171 ±0·013.

T Monocerotis is also supposed to belong to this class. It has the longest period of any, and the maximum variation of 2·5 magnitudes does not fit in with Clause 2 in the δ Cephid charter. Also, the fact that it is supposed to have a secondary minimum would, were it proved, render void its claim to admission into this select body.

Cluster Variables.

The short-period variables of the remaining group are distinguished by the fact that they almost invariably occur in clusters; hence the name. This extraordinary fact, which at first sight would appear to demand a simple explanation, has, so far as the writer is aware, baffled the ingenuity of man in inventing any theory, to sày nothing of a satisfactory one, to account for it.

In addition to existing in aggregations, which rule has very few exceptions, cluster variables are characterised by a very short period (generally well under a day, and in one case as short as three hours twelve minutes), which they execute with great regularity and a singularly shaped light-

that several of these bodies vary in such a way that the sum of the light emitted by both components is a constant. γ Virginis is a typical example of this class.

Colour Variability.

Not only is the light of many of the stars known to be variable, but there is very good evidence to show that the colour varies also in a few cases.

Sirius is described by Ptolemy as fiery red (ὑπόπυῤῥοι); Seneca calls it redder than Mars; Horace uses the term "rubra canicula" as typical of summer heat; Festus describes the custom of sacrificing red dogs at the feast of Floralia to appease the Dog-star; and Cicero, translating Aratus, refers to its "ruddy light." At present no one would dream of calling it anything other than bluish white.

Algol is mentioned by Al Sûfi amongst the exceptionally coloured stars, and in the early part of last century a careful observer noted it as yellow-red on one occasion. It is usually very white.

α Ursae Majoris is said to fluctuate between red and yellow in 51·5 days, and there are many other stars which show decided signs of having undergone colour changes.

In addition to this, all new stars and red variables are also colour variable: the Novae are generally red early in their career, and become leaden white as they fade, while red variables become redder as they get fainter. This latter, however, may be only a physiological effect.

METHODS OF MEASURING THE BRIGHTNESS OF THE STARS.

The earliest observations on stellar variability were much hampered by want of an accurate scale. The stars were divided into magnitudes in a more or less haphazard fashion. To render accurate measurement possible, and at the same time to upset existing nomenclature as little as possible, it was arranged that a fall from one magnitude to the next should be equivalent to a fall in light of 2·512 to 1. (This number is chosen as having 0·4 for its logarithm.) Thus, a third magnitude star gives out 2·512 times as much light as a fourth-magnitude one.

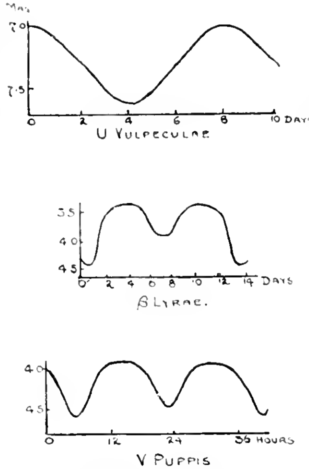


FIGURE 228. Light curves of Geminid Variables.

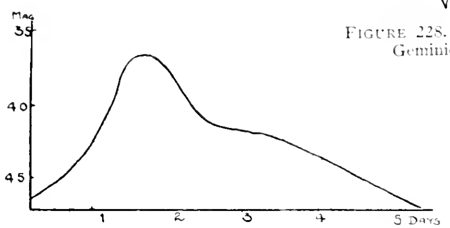


FIGURE 229. Light-curve of δ Cephei.

Having fixed on our scale, the next thing is to use it. The earliest method was to compare the star under observation with a number of stars whose magnitude was already fixed, and find which it equalled, or, failing this, to select one a little brighter and one a little fainter, and, dividing the difference between them into steps, to put the observed variable on that step to which its brightness seemed to entitle it. Thus, suppose two stars, *a* and *b*, and that the observer considers that he can divide the brightness between them into four steps, and, further, that the variable *v* is nearer in brightness to *a* than to *b*, he would enter his observation thus: *a* 1 *v* 3 *b*. If the variable lies midway between the two, the observation is entered *a* 2 *v* 2 *b*, while if it is nearer to *b* than to *a* the entry is *a* 3 *v* 1 *b*. This is known as Argelander's method, and in the hands of experienced observers much good work can be done with it on the brighter variables, while a pair of binoculars will very considerably extend the field of research. The method has the advantage of requiring no instruments, or at most only a field glass, and of not taking much time. On the other hand, it requires fine weather, fair eyesight, and a considerable stock of patience.

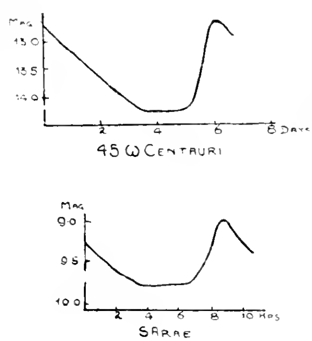


FIGURE 230. Light-curves of Cluster Variables.

For more accurate work, Professor Pritchard, of Oxford, introduced the wedge photometer. This consists of a wedge of tinted glass and a similar wedge of plain glass superposed, as shown in Figure 231. This is slid over the eye-piece of a telescope, until the star is just extinguished, and the thickness of the tinted glass interposed is then measured by measuring the distance through which the wedge has been moved. This process is repeated several times on a fundamental star, and on the other star under observation, and from the mean differences in the two series of observations the difference in magnitude of the stars can be calculated. The instruments used at Oxford consisted of a four-inch and a three-inch telescope, and the magnitude of two thousand seven hundred and eighty-four stars was determined, and published in the *Uranometria Nova Oxoniensis*.

Professor Pickering, of Harvard, employs a fixed telescope, into which he reflects an image of the pole star under observation: by means of a polarising apparatus both the images are made of the same intensity, and from the amount of rotation of the polariscope required to obtain this result the difference in magnitude can be determined. As

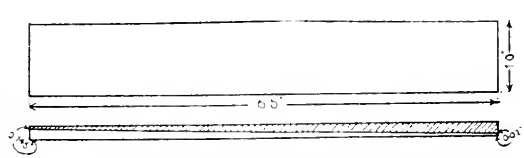


FIGURE 231. Wedge Photometer (half size).

Polaris has been shown to be variable, it will be necessary to apply a correction to the results obtained by this method.

The limit of clearly defined difference that can be observed between two stars by either of these methods is about 0·1 magnitude.

A simple and ingenious method, requiring no expensive adjuncts to the telescope, is mentioned in the *Proceedings of the Liverpool Astronomical Society*. The field of view of the telescope is illuminated, and the eye-piece is racked out until the brightness of the star equals the brightness of the field—that is, until the star disappears. This is repeated several times on a standard star, and on the star whose brightness is required, and the difference in the two means is a function of the difference of magnitude.

We now come to the last, and probably most accurate, method of stellar photometry, *i.e.*, the photographic method. It has the disadvantage that in many cases the results obtained are not strictly comparable with those obtained by visual methods. On the other hand, there are some occasions when it is the only possible method to use, *i.e.*, in the case of very faint variables.

The method almost invariably employed in working out the magnitude of a star from its image on the photographic plate depends upon the fact that the light falling on the plate spreads outwards and produces a small disc. The brighter the star, the larger this disc. The formula generally employed for deducing the magnitude is $M = a - b\ \sqrt{d}$, where M is the required magnitude, d the diameter of the star image, and a and b are constants, a depending on the atmosphere and b on the plate and unit of measurement. These can be deduced by measuring two stars of known magnitude on the plate. The method is liable to several errors, but most of them are easy to obviate. The principal one is under-exposure, which gives an image which is not black all over, and will show a higher magnitude than it should. Inaccuracy in focusing is likely to be another fruitful source of trouble.

Generally speaking, however, the method is very suitable for photometric work, and, with care, will give results of a high degree of accuracy, as well as permanent records which can be measured at any convenient time.

SOLAR DISTURBANCES DURING MAY, 1914.

By FRANK C. DENNETT.

SOLAR observations were made every day during May. On three days only (10th, 13th, and 14th) did the disc seem free from disturbance. On thirteen (1st to 4th, 6th, 18th, 21st to 25th, 29th, and 30th) dark spots were visible, whilst on the remaining fifteen faculae were seen. There was less activity than in the previous month. The Central Meridian at noon on May 1st was 86° 54′.

As Nos. 9 and 10 remained visible until May 4th and 3rd respectively they reäppear upon our present chart.

No. 11.—A small bright-lipped pore situated in a faculic cloud in high southern latitude only seen on the 6th, but the faculic cloud was visible on the 5th and 7th.

No. 12.—When first observed on the morning of the 21st two spotlets were seen, but by two p.m. tiny pores showed closely behind the western spot; slight changes were noted from day to day until last seen upon the 24th. The length of the group was fifty-six thousand miles.

No. 13 was a group composed of one larger and two smaller pores within the area of No. 9, and only seen on the 22nd.

No. 14 on the 29th appeared as a solitary spotlet, but next day as a group of three; not, however, seen after.

Additionally a small very dark spot is recorded in southern latitudes on May 3rd, but no measures have come to hand, so that it cannot be included on the chart.

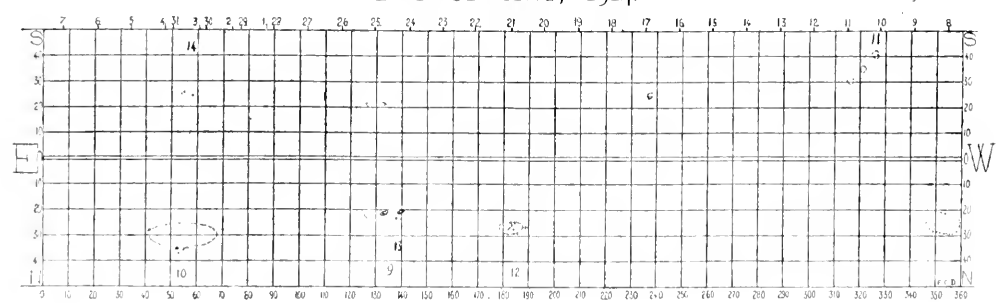
Also on May 18th, in high polar latitudes, a dark spotlet was seen, but not measured.

A pore was also recorded on the 24th, near longitude 202°, in somewhat lower latitude than No. 12. Other pores were noted on the 25th.

Faculae were noted close to the western limb on the 4th, both in north and south latitudes. The fine faculic remains of No. 10 were seen on the 8th and 9th. A bright area around 238°, 26° S. latitude, was seen on the 11th and 12th, and faculae round and about 316°, 30° S. latitude, on the 15th and 16th. The faculic remains of No. 9 were seen on the 19th; also a group round 130°, 21° S. latitude, on the 20th. The faculic remains of No. 12 continued visible on the 26th. Some remnants of the faculae of No. 10 were still visible on the 27th and 28th, as well as that of No. 13. On the 30th and 31st the remains of No. 9 were again visible, as well as a large area around 352°, 25° N. latitude.

Our chart is constructed from the combined observations of Messrs. John McHarg, A. A. Buss, E. E. Peacock, J. C. Simpson, and the writer.

DAY OF MAY, 1914.



STRUCTURAL MODIFICATION AND SPECIALISATION OF FUNCTION.

By HAROLD A. HAIG, M.B., M.R.C.S.

(*Late Lecturer in Histology and Embryology, University College, Cardiff; Research Fellow, University of Aberdeen.*)

The correlation in an organism between histological differentiation and specialisation of function is a principle depending upon factors, many of which are capable of explanation, and others which, as yet, are not fully understood. Thus, the successive developmental phases which are passed through by any vertebrate type from the fertilised egg-cell to the cell-complex which constitutes the animal at birth, show quite clearly that ancestral influences are at work, and that, given adequate facilities for obtaining nutrition, the cells which compose the several germ-layers (epiblast, mesoblast, and hypoblast) have impressed upon them a specific capacity for producing specialised cell-aggregates or tissues; whilst, on the other hand, the actual underlying causes which bring about the differentiation of the cells of various tissues are frequently of so obscure a nature that the biologist is forced to admit that, although he may know something of the forces at work, he has no knowledge of the manner in which these forces are coördinated.

The *animal cell*, of which the unfertilised ovum may be taken as a typical example (see Figure 234), possesses a structure which has been rendered more or less evident by means of the microscope. Examined in the living condition, it is seen to be composed of a small spheroidal mass of semi-fluid viscid material of a somewhat granular appearance, the *cytoplasm*, in which is suspended a *nucleus*, the latter possessing a well-defined rounded refractile spot, the *nucleolus*, in its interior.* With the exception of the youngest ova, this cell is enclosed by a firm membrane—the *zona pellucida*—a secretion either of the ovum itself or of certain follicular cells which surround the ovum in the ovary, and form with the ovum the structure known as a Graafian follicle.

When submitted to certain processes of fixation and staining, both cytoplasm and nucleus give evidence of possessing a definite, finer structure; thus the cytoplasm frequently shows a fibrillar or, at times, a vacuolated appearance,† whilst the nucleus has suspended in its substance a network, upon which granules of a substance known as chromatin are arranged. The granules in the cytoplasm are for the most part of the nature of food-substances (so-called deutoplasm, or yolk).

The ovum, subsequent to fertilisation, apart from certain changes which take place in the nucleus and the acquirement of a centrosome, a minute body taking part in the process of mitotic nuclear division, is structurally but little changed, but there is no doubt as to its intrinsic difference from the unfertilised ovum. It is capable of dividing, and the resulting cells are endowed with the same capacity, which, if kept stimulated by adequate conditions of environment and nutrition, remains unabated until such time as rudiments of all the tissues and organs have been formed.

The ovum is, however, a specialised cell, just as much as a nerve-cell or a muscle-cell is specialised; nevertheless, in microscopical structure, it may not appear highly differentiated in comparison with these others. The fertilised ovum may be looked upon as even more specialised than the unfertilised, in that its capacity for cell-division is greatly enhanced.

With regard to the early changes taking place during the establishment of any of the tissues or organs, in other words, the histogenesis of these, it has been shown that such changes do not occur at one and the same time in all of them. Thus, two of the earliest tissues to become laid down are those going to form the skin and central nervous system on the one hand, and the connective tissues on the other; but, even in these, full development is not completed until a late period of foetal life, establishment of external form being secured some time before histogenetic changes have wrought much differentiation of the component cells. It is, in fact, a well-established axiom that the more complex the ultimate function to be carried out by a tissue or organ, the longer will the histogenetic changes take to complete.

The more immediate object of the present article is to give some idea of the changes in structure which certain tissues or organs may undergo during their progress towards functional perfection, and in this respect a selection may be made of one or two of the special sense-organs, as forming an interesting study in connection with the correlation existing between structural modification and function. Moreover, it will be advisable to confine our selection to a consideration of the more essential

* The terms "nucleus" and "nucleolus" have been chosen as being more suitable than the older terms, "germinal vesicle" and "germinal spot."

† Such appearances are, however, at times of the nature of artefacts.

parts of these organs, such as the sensory epithelium and its nervous connections, those parts which subserve the roles of support or movement of the whole or part of the organ being only very briefly described when deemed necessary.

To begin with, it should be borne in mind that the general scheme of a sense-organ, with its nervous connections, is as follows :—

1. **A central sensorium in the brain.**
2. **One or more collections of nerve-cells, forming so-called "relays" upon the sensory path: these at times form definite ganglia.**
3. **A peripheral end-organ, composed of either a simple or a compound epithelium, upon some of the cells of which nerve-fibres form the nearest relay-end.**

A simplification of this scheme is encountered in the case of the sense of smell, in which the basal ends of certain cells (olfactory cells) of the peripheral end-organ are themselves prolonged as nerve-fibres to the first relay. Usually, the nerve-fibres from the nearest relay of nerve-cells form an arborisation (synapse) with processes from cells of the sensory epithelium, or they may end actually upon the cell-bodies of these cells. In the above scheme the arrow indicates that the sense-impulse passes from the periphery to the centre in the brain.

If we take, at the outset, the sense of *sight*, we find at one end of the path the visual sensorium in the occipital lobe of the brain, intermediate relays in certain of the basal ganglia, and at the periphery the sensory epithelium, formed by that complex inner coat of the eye, viz., the *retina*. A brief account of the development of the retina will not be out of place, and will, moreover, be of use in following out the differentiation of the cells of the various layers met with. The rudiment of each eye begins to form at an early stage of embryonic life, and is first seen as an outgrowth from the side of the fore-brain. This outgrowth is known as the primary optic vesicle (see Figure 238 A, *op. v.*). It is hollow, and its wall is composed of several layers of undifferentiated nervous elements of two kinds, viz., *neuroblasts* and *spongioblasts*, the former being forerunners of definite nerve-cells, the latter giving rise, during later stages, to certain peculiar supporting elements having a purely mechanical function. Very soon an invagination occurs at the most prominent part of the optic vesicle, so that a cup-shaped depression is formed; and this goes on until the part of the wall pushed in comes to lie close up against the original lateral and hind walls of the vesicle, very much as when a rubber ball is dimpled in, the bottom and sides may be made to meet the inner surface of the remainder of the ball. The eye-rudiment has now reached the stage known as the *secondary optic vesicle* (see Figure 238 B and C, *op.*). Of the double wall now seen, the outermost, *i.e.*, that farthest from the brain, will form the retina proper, that next the brain forming the pigmented epithelium of the retina of later stages (see Figure 236, R and P). The rudiment of the sensory epithelium formed in the above manner is composed of a good many tiers of comparatively undifferentiated cells, which have been derived ultimately from the outer germ-layer, or epiblast. As development proceeds, these cells become arranged into several compact layers, but the cells composing the various layers are for the most part similar in appearance to one another, and remain so for some time. In the human embryo of five and a half months' development the retina is represented by seven well-defined layers; but these are not all cellular in structure, some being composed merely of interwoven processes derived from zones on either side of a given layer; moreover, the number of layers is not increased during later stages, so that further differentiation results in a modification of the component elements of layers already laid down.

It will now be as well to examine the microscopical appearance presented by a vertical section of the fully formed retina of any one of the higher mammals; such a section, if thin and appropriately stained so as to show up the various elements, will reveal the following details (see Figure 232):—

Passing from without inwards—

(*a*) A layer of cells containing pigment, and only one cell thick. This is the pigmented epithelium of the retina, and, as has been seen, is derived from the thinner outer wall of the secondary optic vesicle.

(*b*) A layer of "rods" and "cones," which are the outer segments of peculiarly modified cells. The rods alternate with the cones, the former possessing the shape of an elongated cylinder, whilst the latter are somewhat shorter, and not unlike the peg of a peg-top. Both are translucent when untreated by fixing reägents, but may show peculiar refraction effects which give them a striated appearance.

(*c*) A delicate membrane, the so-called external limiting membrane.

(*d*) The outer nuclear layer, composed of the nuclei and delicate cytoplasmic portions of the rod and cone cells: these nuclei may also present peculiar transverse striations.

(*e*) A layer, the outer synapse layer,* made up of the interlacing protoplasmic fibrils derived from the inner ends of the rods and cones on the one hand, and outwardly passing processes from cells of the layer next internal (bipolar cells).

* Sometimes known as the outer molecular layer.

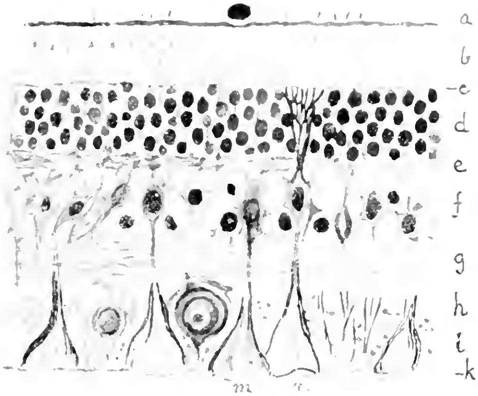


FIGURE 232. A vertical section of the Rabbit's retina.

[illegible]

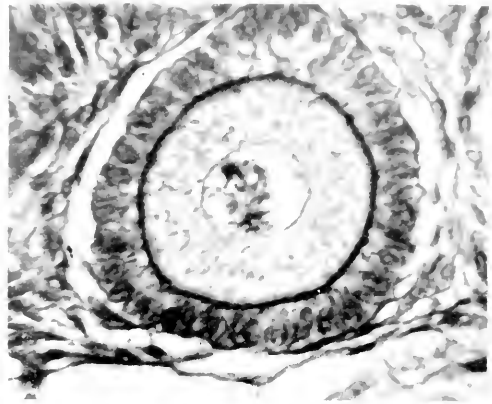


FIGURE 234. A young Graafian follicle from the ovary of the Rabbit.

[illegible]

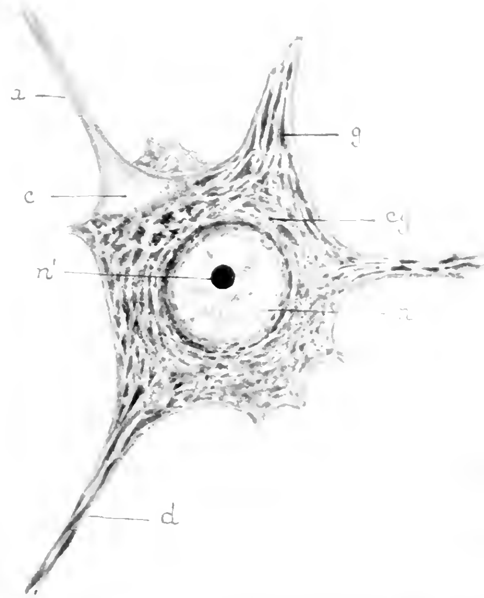


FIGURE 233. A single multipolar [illegible] from the anterior horn of grey matter of the Sheep's spinal cord, stained with methylene-blue by Nissl's method.

[illegible]

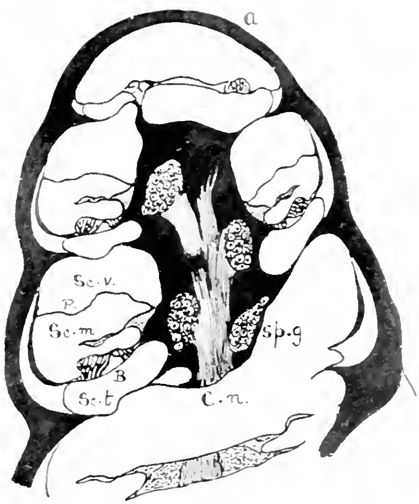


FIGURE 235. A radial [illegible]

[illegible]

FIGURE 2[illegible].

A [illegible] section through the developing eye [illegible] secondary optic vesicle of the [illegible]-day Chick.

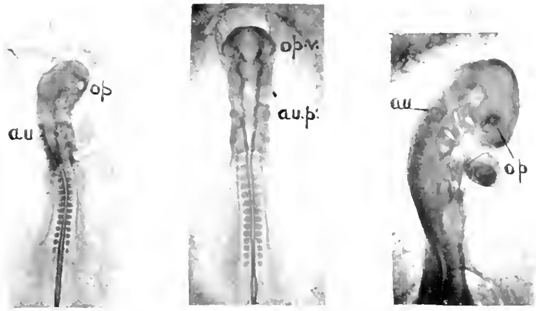


FIGURE 238.

Chick-blastoderms of the 2nd [illegible] and 3rd [illegible] and [illegible] days of incubation the developing embryos show incidentally rudiments of the central nervous system, eye and ear, and vertebral column.

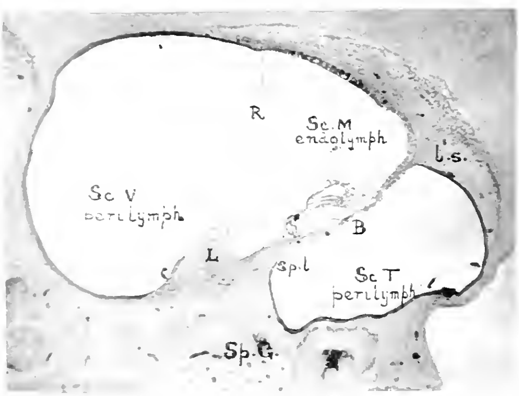


FIGURE 237.

A vertical section [illegible] turn of the cochlea of a Guinea-pig.

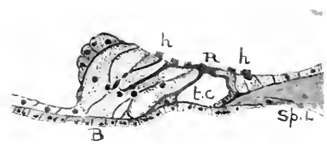


FIGURE 239.

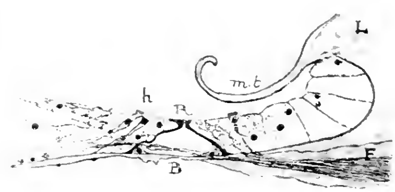


FIGURE 240.

Vertical Sections through the organ of Corti in the Guinea-pig (Figure 239) and Rat (Figure 240).

The other letters as in Figure [illegible].

(*f*) A layer of modified nerve-cells known as bipolar cells: their nuclei form an obvious feature, and of the two processes given off by each cell, one passes into the outer synapse layer, the other into the layer next internal.

(*g*) The inner synapse (or molecular) layer, composed of a dense entanglement of fibres derived on the one hand from the bipolar cells, and on the other from outwardly passing fibres (dendrons) of large nerve-cells in the next layer (optic nerve-cells).

(*h*) A zone in which certain very large nerve-cells, the optic nerve-cells, may be seen. Each of these possesses two main processes, one of which passes into the inner synapse layer; the other, after a short vertical course, turns at right angles, and becomes a single fibre of the optic nerve. These fibres run parallel with one another for some distance, the whole set forming the nerve-fibre layer of the retina; but when they reach a point situated at about the centre of the back of the eye, they bend outwards, and together form the trunk of the optic nerve. Many of the fibres subsequently cross over to the opposite side of the brain, at a part known as the optic chiasma, but some continue on the same side, whilst both sets finally end by forming arborisations in the neighbourhood of nerve-cells of the first relay on the sensory path. The latter cells give rise to fibres which transmit the sense-impulse to cells of the second relay, and so on, until, finally, the visual sensorium in the occipital lobe of the brain is reached, in which certain large cortical cells receive the impulse; and here, by an as yet unexplained process, the latter is interpreted as sight.*

It is not intended here to go into the question of the physiology of the sensation of sight, but it may be mentioned in passing that before the actual stimulus affects the optic nerve-fibres it must first pass via the rods and cones, of which the latter appear to be more readily stimulated than the former, and then through the other layers of the retina from without inwards in order; in fact, the rods and cones may be looked upon as a peculiarly modified end-epithelium, and the bipolar cells and large optic nerve-cells as early relays upon the sensory path. Finally, the light-impulse, travelling as a peculiar molecular change, passes along the fibres of the optic nerve to the brain.

In the retina, as above described, there are certain elongated cells, curiously modified so as to form supporting elements: these, the fibres of Müller (see Figure 232 *m*), pass from the surface of the internal layer, where their expanded, funnel-shaped extremities blend to form an internal limiting membrane, through the other layers, until they end in a sort of basket-work of fibrils upon the external limiting membrane. Their nuclei are situated in the layer of bipolar cells (see Figure 232 *f*).

Looking now upon the retina from the point of view of the question of structural modification in response to functional requirements, it is almost impossible to conceive of a more elaborate example of such modification. Many of the elements in the retinal layers retain the characters of nerve-cells, but, on the other hand, the rod and cone cells and the fibres of Müller have departed very markedly from the original type. The optic nerve-cells are possibly those most nearly related to the typical nerve-cell, as evidenced by their shape and the possession of those peculiar bodies, the Nissl granules, which are characteristic of the cell-protoplasm of all typical neurones (see Figure 233), whether motor or sensory in function. These granules may also be detected in the bipolar cells; they stain intensely with such dyes as methylene blue, and have been shown to have both phosphorus and iron in their composition, their chemical reäctions placing them among the group of nucleo-proteïds. If a nerve-cell becomes fatigued, the Nissl granules disperse, and a diffuse staining of the cytoplasm with methylene blue is noticed (so-called chromatolysis).

The series of changes taking place in the original neuroblasts and spongioblasts of the embryonic retina, and giving rise, ultimately, to the highly-differentiated elements found in the fully-developed structure, can be followed out step by step. Moreover, by means of certain histological methods (the so-called chromate of silver methods of Golgi and Cajal), many of the individual cells can be picked out, rendering it possible to trace the connections existing between the elements of the various layers, and so on, to the remoter relays in the sensory path. The underlying causes, however, of the peculiar structural modifications undergone by the embryonic cells are not at all clear, but probably this is a question which can only be approached by a consideration of evolutional factors; as, for instance, by reference to developmental features of the eye of lower animals. However, the retinae of most vertebrates conform to a distinct type, of which the above description gives a brief histological résumé.

The other special sense to be examined as an example of complexity of modification in response to function is that of *hearing*, the sense-organ concerned being a certain part of the internal ear, viz., the *cochlea*. Although, in some respects, the sensory epithelium is not so complicated as that of the retina, it becomes, nevertheless, considerably modified.

* The names and situations of the various relays on the sensory path have been purposely omitted.

The early developmental features of the internal ear are somewhat different from those of the eye, in that the rudiments of the sensory epithelium are derived from the epiblast at the sides of the head, and not from the cerebral vesicle at all. The epiblast at the side of the head, close to the hind-brain rudiment, becomes pushed in to form on each side a shallow depression, known as the *auditory pit* (see Figure 238 A and B, *au. p.*), and this pit becomes deeper, being finally shut off from the original epithelium in the form of a sac, the *auditory*, or *otic vesicle* (see Figure 238 C, *au.*).

Each vesicle is close to the lateral aspect of the hind-brain, and constitutes at this stage the simple sac-like rudiment of the internal ear. Further stages show that this sac, which is thus seen to be lined by an epithelium derived from the epiblast, becomes modified so as to form a complex system of cavities, the outer walls of these being membranous in structure, and constituting the membranous labyrinth. In certain places the epithelium becomes columnar in type, and forms definite patches of sensory epithelium, and these occur in the following situations,* viz., the utricle, saccule, the three ampullae of the semicircular canals, and along the whole inner border of the spiral curve of the cochlea. Whilst, however, the modified epithelium of most of the above is concerned with the function of equilibration, that lining certain parts of the cochlea is set off for the sense of hearing and the analysis of musical sounds; it is this latter region which will now be more fully described.

The cochlea of a human embryo of about three months' development already possesses the spiral arrangement characteristic of the fully developed organ, the spiral being one of two and a half turns round a central axis known as the modiolus or columella. During its development the internal membranous and epithelial sac becomes encased in a cartilaginous capsule (otic capsule), which, later on, undergoes a process of ossification, in common with the other cartilaginous rudiments surrounding the remainder of the membranous labyrinth.

A vertical section taken through the cochlea at this stage will show the turns of the coil cut across on either side of the central axis, the latter, which is also cartilaginous at this stage, being traversed from base to apex by the cochlear division of the eighth cranial nerve.

Projecting from the modiolus is a sort of spiral platform, known as the *lamina spiralis*, and attached to the free edge of this is a membrane (covered on both sides by epithelium) which stretches across towards the outer wall of the cochlea, and becomes attached to another spirally wound projection, the spiral ligament. This membrane is the *basilar membrane*, and upon its upper surface are arranged the component cells of the essential sensory epithelium. During early developmental phases the cells of this epithelium are, towards the middle of the basilar membrane, elongated and columnar in shape, with somewhat clear borders, whilst on either side they pass into the type of cell known as cubical.

There is another membrane, viz., *Reissner's membrane*, situated somewhat above the basilar, and the two, stretching across from the modiolus to the outer wall, divide the cavity of the cochlea into three compartments, lined by epithelium: the uppermost is known as the *scala vestibuli*, the middle one the *scala media*, or canal of the cochlea, the lowest being the *scala tympani*. In a vertical section these are, of course, seen as spaces lined by epithelium of the general characters noted above. The columnar epithelium upon the upper surface of the basilar membrane becomes modified during later stages of development to form what is known as the *organ of Corti*. The modified cells are partly sensory and partly supporting in function, and the former become intimately associated with nerve-fibres derived from nerve-cells of the first relay. These cells are collected together into a spirally arranged mass known as the spiral ganglion, which in vertical sections of the cochlea is seen cut across several times on either side of the modiolus (see Figure 235, *sp. g.*). Each cell of the spiral ganglion is bipolar in type, that is to say, two nerve-fibre processes are given off from opposite poles of the cell, one of these fibres passing, as has been mentioned above, to the epithelium of the organ of Corti, the other taking a central course towards the brain, to end round a cell of the next relay, from which the impulse is passed on to the sensorium.† A vertical section through the cochlea at the height of its development will show the above-described cochlear structures after they have been modified to fulfil their functional requirements. A good idea of the actual structure may be obtained by considering the section of one single turn of the cochlea, and in this the following details can be made out (see Figures 235 and 237):—

(*a*) The basilar membrane (B), stretching across from the spiral lamina (*sp. l.*) to the spiral ligament (*l. s.*), the latter being a projection inwards of the lining membrane of the outer wall. Upon the upper aspect of the basilar membrane is situated the organ of Corti, and this is partially roofed over by a peculiar tongue-shaped (in section) flap of connective tissue known as the *membrana tectoria*, which is attached by its base to a projection of connective tissue (the limbus, L), seen just above the spiral lamina.

(*b*) The three scalae (vestibuli [*sc. v.*], media [*sc. m.*], and tympani [*sc. t.*]): of these the

* The terms here used denote anatomical names of certain parts of the labyrinth.

† A certain part of the cortex of the temporo-sphenoidal lobe.

upper and the lower are during life filled with a fluid known as *perilymph*, whilst the scala media contains another fluid, the *endolymph*. The scalae vestibuli and tympani communicate with one another at the apex of the cochlea (helicotrema), but the canal of the cochlea is a closed space, any vibrations reaching the perilymph being transmitted either through the basilar membrane or the membrane of Reissner, or possibly both of these.

The most important part of the above apparatus is the *organ of Corti*, and this is composed of modified columnar epithelial cells, some of which function as receptors of sound-vibrations, others being of a purely supporting character (so-called sustentacular cells). The latter are found alternating more or less with the true sensory cells. There is a large number of both types of cell arranged in regular series upon the upper surface of the basilar membrane from the base to the apex, and it is a noteworthy point that the membrane is broader at the apex than at the base of the cochlea. In thin sections, however, it is obvious that only one row of the cells is seen. Two of the supporting cells in each group form very definite objects, and these, which are propped up against one another at a somewhat obtuse angle, are known as the *rods of Corti* (see Figures 239 and 240, R), outer and inner respectively; the rods, together with a portion of the basilar membrane, enclose a space known as the tunnel of Corti, which contains endolymph. The outer rod is described as having a swollen upper extremity, or "head," from which a process (phalangeal process) projects upon the outer side, and the base, which rests upon the basilar membrane, is somewhat flattened out, and has upon its inner aspect a nucleated cell, which represents the original cell from which the rod is derived. The inner rod is shorter, less obliquely set upon the basilar membrane, with a "head" portion which articulates with the head of the outer rod, and a broad base, having a cell upon its outer aspect similar to that accompanying the outer rod.

The true sensory cells lie, one set to the outer side of the outer rod, the other set to the inner side of the inner rod. The outer set are more columnar, and have amongst them a few supporting cells (Deiter's cells), not unlike the rods of Corti, at their free extremities, their lower ends being nucleated protoplasm.

The sensory cells, or *hair-cells*, more properly called, have at their free ends a number of stiff, bristle-like structures (see Figures 239 and 240 *h*.), or acoustic hairs, which project through a kind of perforated membrane, formed in all probability by the fusion of the upper ends of the supporting cells. Altogether, in each group, there are from five to six hair-cells in the outer set and two or three in the inner set, whilst the latter are individually shorter and more cubical in shape than those of the outer set. The surface view of the basilar membrane, with the organ of Corti resting upon it, has a considerable resemblance to the keyboard of a piano, and this has led to certain theories being advanced as to the manner in which the whole structure responds to sound-vibrations travelling in the endolymph, one being that special hair-cells pick out special vibrations, another that the whole basilar membrane responds, and that the "sorting-out" process takes place in the brain. Neither theory is, however, adequate to explain what really takes place, but from certain symptoms observed in cases where the cochlea is diseased, it appears that the organ of Corti at the base responds to notes of different frequency from those affecting the hair-cells at the apex, where, as has been seen, the basilar membrane is broadest.

SUMMARY AND CONCLUSIONS.

In both the sense-organs above described it will have been noticed how the sensory epithelium is modified during development to possess two distinct types of cell, viz., one the true sensory cell, which receives and transmits the vibration (light, sound, and so on), the other the supporting cell which subserves a purely mechanical function; in fact, much the same state of affairs may be recognised in any end-organ. The supporting cells, during early stages, are able to secrete a very tough resistant substance, or even to become partially converted into this material, which gives very much the same staining reäctions as *keratin*. A similar substance, known as *neurokeratin*, occurs as a sort of sheath in the supporting cells (neuroglia cells) of the central nervous system, and also, to a less extent, in the true nerve-cells and their processes.

As to why the various sensory cells, with their peculiar terminal modifications (hairs, rods, cones, and so on), should be able to receive and transmit certain vibrations, or, in other words, to transform varieties of energy into the molecular change known as an impulse, is as yet not fully solved; but there is no doubt as to the intrinsic difference between a sensory cell and one of the type known as "secretory" or "protective" (skin, and so on). As has been seen from the above considerations, the structure of the sensory cell is determined during comparatively early stages; but, even then, it would appear that the most important modification lies not so much in the obvious structural configuration of the cell as in some peculiar and as yet unknown molecular arrangement of the actual cytoplasm, rendering it particularly susceptible to the influence of specific forms of energy. Finally, it is highly probable that the passage of an impulse through such a sensory cell is accompanied by rapidly alternating katabolic and anabolic reäctions, similar to those which undoubtedly occur in a muscle-fibre during contraction.

THE FACE OF THE SKY FOR AUGUST.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 32.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Aug. 1	8 42·2	N. 18·2	16 30·6	S. 27·3	7 25·5	N. 19·3	11 22·7	N. 4·0	11 31·6	N. 3·0	21 25·3	S. 16·2	5 50·2	N. 22·3	20 49·3	S. 18·5
„ 6	9 2·3	16·9	21 [illegible]	S. 16·7	7 42·0	20·0	11 43·2	N. 2·3	11 42·4	2·0	21 22·7	16·4	5 52·5	22·3	20 48·5	18·5
„ 11	9 21·6	15·5	1 0·1	N. 11·3	8 11·0	20·0	12 3·3	S. 0·2	11 53·[illegible]	N. 1·3	21 20·2	16·6	5 54·7	22·3	20 47·7	18·6
„ 16	9 40·4	13·9	5 10·7	N. 25·2	8 45·2	18·9	12 23·2	2·7	12 5·3	0·0	21 17·0	16·8	5 56·8	22·3	20 46·9	18·6
„ 21	9 59·1	12·2	9 50·2	N. 13·1	9 24·3	16·5	12 42·9	5·3	12 16·9	S. 1·3	21 15·0	17·0	5 58·8	22·3	20 46·1	18·7
„ 26	10 17·5	10·6	14 23·2	S. 10·3	10 3·6	13·8	13 2·4	7·8	12 28·0	2·6	21 12·6	17·2	6 0·6	22·3	20 45·4	18·7
„ 31	10 35·7	N. 8·6	19 24·2	S. 25·0	10 41·6	N. 10·2	13 21·5	S. 10·2	12 40·4	S. 3·9	21 10·3	S. 17·4	6 2·4	N. 22·3	20 44·7	S. 18·8

TABLE 33.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
Aug. 1	+10·8	+5·8	300·6	+8·3	−20·2	+0·3	182·9	247·7	4 50 *e*	5 10 *m*
„ 6	12·7	6·2	243·5	−10·8	20·0	0·3	253·1	279·8	5 5 *m*	2 13 *e*
„ 11	14·6	6·5	177·4	−21·3	19·8	0·3	323·3	311·8	10 51 *e*	3 24 *m*
„ 16	16·4	6·7	111·3	−4·7	19·6	0·3	33·4	343·8	1 15 *m*	10 22 *e*
„ 21	18·0	6·9	45·2	+16·0	19·4	0·3	103·5	15·7	7 1 *e*	11 34 *m*
„ 26	19·5	7·1	339·1	+15·2	19·2	0·2	173·5	47·6	7 16 *m*	2 40 *m*
„ 31	+20·9	+7·2	273·1	−7·3	−19·1	+0·2	243·4	79·4	3 11 *e*	7 44 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}4$, $9^h\ 55^m{\cdot}6$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving southward with increasing speed. Its semi-diameter increases from 15′ 47″ to 15′ 52″. Sunrise changes from $4^h\ 23^m$ to $5^h\ 13^m$; sunset from $7^h\ 49^m$ to $6^h\ 47^m$.

ECLIPSE OF THE SUN, AUGUST 21ST.—This Eclipse is total across Greenland; the central line runs from Alstenö, on the Norwegian coast, to Hernosand, on the Baltic coast of Sweden, enters Russia a few miles N.E. of Riga, passes Minsk, Kiev, and Feodosia (Crimea), then crosses the Black Sea and enters Western Asia, traversing Persia and ending in N.W. India. The totality track in Europe extends for fifty miles on each side of the central line, where the duration of totality is $2^m\ 12^s$. Partial eclipse is visible in N. America (part), Europe (whole), N.E. Africa, western half of Asia.

Table 34 gives particulars for the partial eclipse as seen from some stations in the British Isles. The times are in Greenwich Time, except for Dublin and Armagh, where Dublin Time is used.

TABLE 34.

Place.	Beginning. Time.	Beginning. Angle from N.	Greatest Phase. Time.	Greatest Phase. Magnitude.	End. Time.	End. Angle from N.
	h. m.	°	h. m.		h. m.	°
Armagh	10 24 *m*	325	11 34 *m*	0·638	0 43 *e*	103
Dublin	10 25 *m*	326	11 35 *m*	0·620	0 45 *e*	102
Glasgow	10 50 *m*	322	0 1 *e*	0·695	1 11 *e*	106
Edinburgh	10 51 *m*	321	0 2 *e*	0·707	1 12 *e*	107
Liverpool	10 54 *m*	325	0 5 *e*	0·656	1 15 *e*	104
Durham	10 54 *m*	322	0 5 *e*	0·700	1 15 *e*	107
Oxford	10 58 *m*	326	0 9 *e*	0·642	1 19 *e*	104
Greenwich	10 59 *m*	326	0 11 *e*	0·651	1 21 *e*	105
Cambridge	10 58 *m*	325	0 10 *e*	0·667	1 21 *e*	106

It will be seen that the lines of simultaneous beginning are parallel to the line from Liverpool to Durham, or from Oxford to Cambridge. The lines of simultaneous ending happen to be almost parallel to those of simultaneous beginning.

MERCURY is a morning star, in elongation 19° W. on 5th; on 30th it passes superior conjunction and becomes an evening star. Semi-diameter diminishes from 4″ to 2½″. Illumination increases from ¾ to full.

VENUS is an evening star, ⅔ of disc illuminated. Semi-diameter 9″. The fact of its declination being south of the Sun impairs the conditions of observation for northern observers. 10′ south of Mars 6^d 2^h *m*.

THE MOON.—Full 6^d 0^h 41^m *m*. Last quarter 14^d 0^h 56^m *m*. New 21^d 0^h 26^m *c*. First quarter 28^d 4^h 52^m *m*. Apogee 12^d 10^h *m*. Perigee 24^d 6^h *m*, semi-diameter 14′ 48″, 16′ 24″ respectively. Maximum librations 1^d 7° N., 5^d 5° W., 15^d 7° S., 18^d 6° E., 28^d 7° N., 31^d 6° W. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 35).

MARS is advancing through Virgo. Semi-diameter 2″. The unilluminated lune is on the East: its width is ⅓″. The planet is near Venus on 6th.

JUPITER is in Capricornus, in opposition on 10th. Polar semi-diameter, 22½″.

Configuration of satellites at 11^h *c* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.	
Aug. 1	4	○	132		Aug. 17	42	○	13	
,, 2	214	○	3		,, 18	41	○	32	
,, 3	2	○	143		,, 19	3	○	12	4●
,, 4	1	○	324		,, 20	32	○	4	1●
,, 5	31	○	24		,, 21	321	○	4	
,, 6	32	○	14		,, 22		○	124	3●
,, 7	31	○	4	2●	,, 23	1	⊙	34	
,, 8		○	1324		,, 24	2	○	134	
,, 9	12	○	4		,, 25	1	○	234	
,, 10	2	○	143		,, 26	3	○	124	
,, 11	41	○	32		,, 27	321	○	4	
,, 12	43	⊙	2		,, 28	3421	○		
,, 13	432	○	1		,, 29	43	○	12	
,, 14	4312	○			,, 30	41	○	23	
,, 15	4	○	312		,, 31	42	○	13	
,, 16	412	○	3						

The following satellite phenomena are visible at Greenwich, 3^d 0^h 10^m 57^s *m*, IV. Ec. D.; 4^d 2^h 5^m 15^s *m*, I. Sh. I.; 2^h 15^m 33^s *m*, I. Tr. I.; 4^h 22^m 35^s *m*, I. Sh. E.; 11^h 5^m 11^s *c*, III. Sh. I.; 11^h 24^m 45^s *c*, I. Ec. D.; 11^h 41^m 36^s *c*, III. Tr. I.; 5^d 1^h 52^m 26^s *m*. I. Oc. R.; 2^h 44^m 34^s *m*, III. Sh. E.; 3^h 20^m 51^s *m*, III. Tr. E.; 8^h 33^m 48^s *c*, I. Sh. I.; 8^h 41^m 27^s *c*. I. Tr. I.; 10^h 51^m 11^s *c*, I. Sh. E.; 10^h 58^m 48^s *c*, I. Tr. E.; 6^d 3^h 52^m 33^s *m*, II. Sh. I.: 4^h 7^m 9^s *m*, II. Tr. I.: 8^h 18^m 23^s *c*. I. Oc. R.: 7^d 10^h 7^m 1^s *c*, II. Ec. D.; 8^d 1^h 8^m 19^s *m*, II. Oc. R.; 9^d 8^h 6^m 14^s *c*. II. Sh. E.; 8^h 9^m 43^s *c*, II. Tr. E.: 11^d 3^h 59^m 6^s *m*. I. Tr. I.; 3^h 59^m 34^s *m*, I. Sh. I.; 12^d 1^h 17^m 41^s *m*. I. Oc. D.; 2^h 57^m 8^s *m*. III. Tr. I.; 3^h 5^m 20^s *m*. III. Sh. I.; 3^h 36^m 13^s *m*, I. Oc. R; 10^h 25^m 0^s *c*, I. Tr. I.; 10^h 28^m 12^s *c*. I. Sh. I.; 13^d 0^h 42^m 28^s *m*, I. Tr. E.; 0^h 45^m 44^s *m*, I. Sh. E.: 7^h 43^m 39^s *c*. I. Oc. D.; 10^h 6^m 47^s *c*, I. Ec. R.; 15^d 0^h 29^m 40^s *m*, II. Oc. D.; 3^h 35^m 14^s *m*, II. Ec. R.; 8^h 55^m 19^s *c*. III. Ec. R.; 16^d 7^h 29^m 42^s *c*, II. Tr. I.; 7^h 48^m 22^s *c*. II. Sh. I.; 10^h 24^m 20^s *c*, II. Tr. E.; 10^h 42^m 54^s *c*, II. Sh. E.; 19^d 3^h 1^m 39^s *m*, I. Oc. D.; 11^h 7^m 27^s *c*, IV. Ec. R.; 20^d 0^h 8^m 46^s *m*, I. Tr. I.; 0^h 22^m 46^s *m*, I. Sh. I.; 2^h 26^m 18^s *m*, I. Tr. E.; 2^h 40^m 22^s *m*, I. Sh. E.; 9^h 27^m 41^s *c*, I. Oc. D.; 21^d 0^h 1^m 31^s *m*, I. Ec. R.; 8^h 52^m 19^s *c*, I. Tr. E.; 9^h 9^m 1^s *c*. I. Sh. E.; 22^d 2^h 43^m 48^s *m*, II. Oc. D.; 8^h 2^m 35^s *c*, III. Oc. D.; 23^d 0^h 55^m 57^s *m*, III. Ec. R.; 9^h 45^m 3^s *c*, II. Tr. I.; 10^h 25^m 19^s *c*. II. Sh. I.; 24^d 0^h 39^m 22^s *m*, II. Tr. E.; 1^h 19^m 28^s *m*, II. Sh. E.; 25^d 7^h 29^m 23^s *c*, II. Ec. R.; 27^d 1^h 53^m 2^s *m*, I. Tr. I.; 2^h 17^m 28^s *m*, I. Sh. I.; 11^h 12^m 9^s *c*, I. Oc. D.; 28^d 0^h 2^m 16^s *m*, IV. Tr. I.; 1^h 56^m 26^s *m*, I. Ec. R.; 8^h 19^m 13^s *c*, I. Tr. I.; 8^h 46^m 10^s *c*, I. Sh. I.; 10^h 36^m 43^s *c*. I. Tr. E.; 11^h 3^m 46^s *c*, I. Sh. E.; 29^d 8^h 25^m 10^s *c*, I. Ec. R.; 11^h 21^m 18^s *c*, III. Oc. D.; 31^d 0^h 1^m 27^s *m*, II. Tr. I.; 1^h 2^m 17^s *m*, II. Sh. I.; 2^h 55^m 21^s *m*, II. Tr. E.

Up till the 10th, eclipse disappearances will take place to the left of the disc in an inverting telescope, taking the direction of the belts as horizontal. After the 10th eclipse reappearances will take place on the right. Near opposition the satellites on the disc are very near their own shadows.

SATURN is reäppearing as a morning star, between Taurus and Gemini. Polar semi-diameter 8″. Major axis of ring 40″, minor 18″. Angle P − 6°·0.

Eastern elongations of Tethys (every 4th given) 17^d 3^h·3 *m*, 24^d 4^h·6 *c*, Sept. 1^d 5^h·9 *m*; of Dione (every 3rd given) 17^d 9^h·9 *c*, 26^d 3^h·1 *m*, Sept. 3^d 8^h·3 *m*; of Rhea (alternate ones) 20^d 5^h·7 *c*, 29^d 6^h·7 *c*.

For Titan and Japetus E., W. stand for East and West elongations, I for Inferior (North) conjunction, S. for Superior (South) conjunction. Titan 17^d 5^h·9 *m* I, 21^d 3^h·1 *m* W., 25^d 3^h·5 *m* S., 29^d 6^h·4 *m* E., Japetus 15^d 2^h·9 *c* E.

URANUS is in its best position for the year, being in opposition on 2nd.

NEPTUNE is a morning star, too near the Sun for observation.

COMETS.—See "Notes on Astronomy."

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant.			Remarks.
	R.A.		Dec.	
	°		°	
May-30 Aug. ..	333	−	28	Swift, streaks.
June-Aug. ...	310	+	61	Swift, streaks.
June-Sept. ..	335	+	57	Swift.
June-Aug. ...	303	+	24	Swift.
July-Aug. ..	308	−	12	Slow, long.
July 25-Sept. 15	48	+	43	Swift, streaks.
July-Sept. ..	335	+	73	Swift, short.
July-Aug. ...	280	+	57	Slow, short.
July-October ...	355	+	72	Swift, short.
Aug. 10-13 .	45	+	57	Perseids, swift, streaks.
Aug.-Sept. ..	353	−	11	Rather slow.
Aug. 15 ...	290	+	53	Swift, bright.
Aug. 15-25 .	291	+	60	Slow, bright.
Aug. 25 ..	5	+	11	Slow, short.
Aug.-Sept. ..	346		0	Slow.
Aug.-Oct. 2 .	74	−	42	Swift, streaks,
Aug.-Sept. ...	63	+	22	Swift, streaks.

In the cases where the radiant is stated to be active for several months, there is a difference of opinion as to whether it can be regarded as a single shower or a combination of several.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable (see Table 36).

Table 35. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reäppearance.	
			Time.	Angle from N. to E.	Time.	Angle from N. to E.
1914.			h. m.	°	h. m.	°
Aug. 2 ..	BAC 6160	6·4	10 49 *e*	49	11 51 *e*	293
„ 3 ...	τ Sagittarii	3·5	7 5 *e*	83	8 19 *e*	263
„ 5 ..	η Capricorni	4·8	10 2 *e*	46	11 16 *e*	262
„ 7 ...	Wash. 1513	6·8	—	—	10 25 *e*	226
„ 10 ...	δ Piscium	4·6	—	—	9 16 *e*	215
„ 16 ...	BD + 27°·723	6·5	3 20 *m*	30	4 8 *m*	303
„ 16 ...	136 Tauri	4·6	11 48 *e*	76	0 38 *m**	272
„ 17 ...	BAC 1918..	6·1	2 52 *m*	124	3 41 *m*	223
„ 19 ...	BD + 24°·1806	7·0	—	—	3 36 *m*	263
„ 28 ...	BAC 5603	6·0	6 29 *e*	78	7 41 *e*	296

From New to Full disappearances take place at the Dark Limb, from Full to New reäppearances.

The asterisk indicates the day following that given in the date column.

Table 36. Non-Algol Stars.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
R Sagittae	20 10	+ 16 ·5	8·5 to 10·3	70·56	July 9.
U Cygni	20 17	+ 47 ·6	6·1 to 11·8	464	Aug. 27.
V Cygni	20 38	+ 47 ·8	6·8 to 13·8	418	Aug. 21.
X Cygni	20 40	+ 35 ·3	6·2 to 7·4	6·1	
T Aquarii	20 45	− 5 ·5	6·8 to 13·4	202·75	Sept. 9.
R Vulpeculae...	21 1	+ 23 ·5	7·1 to 13·6	136·8	Oct. 15.
T Cephei	21 8	+ 68 ·1	5·2 to 10·8	387	Nov. 15.
W Cygni	21 33	+ 45 ·0	5·4 to 7·0	irregular.	
u Cephei	21 41	+ 58 ·4	4·0 to 4·8	irregular.	

Minima of Algol $10^d\ 5^h\cdot 3\ m$, $13^d\ 2^h\cdot 1\ m$, $15^d\ 10^h\cdot 9\ c$, $18^d\ 7^h\cdot 8\ c$. Period $2^d\ 20^h\ 48^m\cdot 9$.

Principal Minima of β Lyrae August $7^d\ 1^h\ m$, $19^d\ 11^h\ c$. Period $12^d\ 21^h\ 47^m\cdot 5$.

CORRESPONDENCE.

RUSSIAN PEASANTS' ARITHMETIC.

To the Editors of "Knowledge."

Sirs,—I read with much interest the letter from your correspondent, the Rev. G. T. Johnston ("Knowledge," Volume XXXVII, June, 1914, page 203), relating to the method of multiplication adopted by Russian peasants, and append the following explanation :—

Suppose p and q be any two numbers whose product is required. Let p be the number to be successively halved (ignoring fractions), and q the number on the other side to be successively doubled. Of the successive quotients on the left-hand side, let the odd numbers occur in the r_1th, r_2th, r_3th . . . r_sth terms of the vertical column which commences with p, the r_sth term being, of course, equal to unity. The first odd term is the r_1th, its value being $\frac{p}{2^{r_1}}$; and the nearest even number contained therein is $\frac{p}{2^{r_1}} - 1 = \frac{p-2^{r_1}}{2^{r_1}}$, so that the second odd term, or the r_2th term, is equal to $\frac{p-2^{r_1}}{2^{r_1}\times(2^{r_2-r_1})} = \frac{p-2^{r_1}}{2^{r_2}}$. The third odd term, or the r_3th term, will be equal to $\frac{p-2^{r_1}-2^{r_2}}{2^{r_3}}$, and so on.

The last odd term, the r_sth

$$= \frac{p-2^{r_1}-2^{r_2}-2^{r_3}-\ldots-2^{r_{s-1}}}{2^{r_s}} = 1.$$

$$\therefore p = 2^{r_1} + 2^{r_2} + 2^{r_3} + \ldots + 2^{r_s}.$$

$$\therefore p \times q = 2^{r_1} q + 2^{r_2} q + 2^{r_3} q + \ldots + 2^{r_s} q.$$

The numbers in the right-hand, or "q" column, opposite to the r_1th, r_2th, r_3th, . . . r_sth terms (only those corresponding to the odd quotients being retained), are $q\times 2^{r_1}$, $q\times 2^{r_2}$, . . . $q\times 2^{r_s}$, and their sum is :

$$2^{r_1} q + 2^{r_2} q + 2^{r_3} q + \ . \ . \ . \ + 2^{r_s} q,$$

which is identical with the value of $p\times q$ obtained from the left-hand column.

CHARLES LOMAX-EARP.

Clapham Common, S.W.

ZOÖLOGICAL NOMENCLATURE.

By The Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S.

An appeal to Zoölogists to promote and expedite the publication of Professor Schulze's "Nomenclator Animalium Generum et Subgenerum" by generous financial Support.

1.—There is a tradition that in a bygone age and a distant clime the curator of a vast zoölogical garden was prompted and helped by divine curiosity to name all the animals of the globe. The tradition expressly says that they were all brought to one of our forefathers, to see what he would call them, and whatsoever he called every living creature that was the name thereof. At that date, apparently, there were no questions of priority. But, unfortunately, as printing had not been invented, the names, according to our modern rules, were not technically published. They were all *nomina nuda*—as naked as Adam himself. The consequence is, as most naturalists know, that animals are still being continually brought to us to see what we will call them. Only, the result is far from being the same as that of primaeval simplicity. For a just discovered buffalo, or antelope, you may publish the most appropriate designation possible, only to find that it has been preöccupied in the same month, or a hundred years ago, for a flea or a frog. In the Zoölogical Society of London not long ago, perhaps with humorous intention, two consecutive contributions discussed the same group of invertebrates. Both contributors were distinguished for their long study and thorough knowledge of the subject. Yet the group was called *Polyzoa* by one of the specialists and *Bryozoa* by the other. In the latter half of the eighteenth century it was thought allowable, in the division of a genus, to give generic rank to some of its specific names, and to avoid tautology by giving new specific names to the species thus promoted. Some of us think that what those ancients did when there was no rule against it ought not to be interfered with. On the other hand, some of us think that it ought to be, and that these old persons had no right to disobey our new rules.

2.—These are merely samples to indicate the complexities and entanglements with which the theory and practice of name-giving are beset. In the history of our science more or less indignant protests have repeatedly been raised against changes of names, on the ground that the changes were unnecessary, though, really, they were often inevitable, because, with the progress of knowledge, the framework of classification becomes inadequate for the picture. But for the lower units of the system, the genera and species, there is probably a general desire to exclude fluctuation, so far as is possible, by reasonable rules for the future, whether or not any reasonable compromise can be proposed for the past. It is no part of my purpose now to define what is reasonable, or to express any preference among the various self-constituted lawgivers who issue rules on this subject. My object is to explain the interdependent importance of two monumental works which are seeking to clear the ground on this very subject of genera and species. They aim at presenting us with a minute and orderly survey of our whole kingdom, leaving no holes and corners with unwelcome and disconcerting contents to be spasmodically discovered in the future.

3.—The first of these is the "Index Animalium," in course of production and publication by our English friend and colleague, Mr. Sherborn. The second is the "Nomenclator Animalium," edited by the veteran German professor, Geh. Regierungsrat Dr. Franz Eilhard Schulze. Each in its field of operations should be credited with the same single-minded aim, to give us complete and precise knowledge of the facts in question. It is common to both that enormous labour, with consequent expense, is involved in accomplishing the purpose aimed at. Now, from a considerable correspondence, I have become aware that the relation between these two great works has been misapprehended. It is evidently sometimes thought that the "all-British" production ought to be preferred to a "thing made in Germany." It is also supposed that what has been done, and is being done, by other agencies is all-sufficing. Thirdly, it has been suggested, perhaps ironically, that if Germany wants a work of its own, Germany is quite rich enough to pay for it.

4.—If, now, I wish to advocate the claims of Dr. Schulze's "Nomenclator," let it not be thought that I am wanting in zeal for Mr. Sherborn's "Index." In its early days that also was exposed to some amount of prejudice. Many years ago I happened to be on the Committee of Recommendations of the British Association. Section D, after its manner, was asking for many grants, including one for the "Index Animalium." But the distinguished president of the Section that year cared not a jot for names. He refused to open his mouth in favour of the "Index." Accordingly, in the strenuous fight for money, that grant must have inevitably fallen through had I not presumptuously intervened, and, almost against hope, prevailed on the committee to make it. May that be a favourable omen for the success of my present pleading!

5.—Will my readers, then, be pleased to consider the difference in the scope of the two undertakings? Mr. Sherborn desires to supply a list of all the generic and specific names that have been applied to animals between the beginning of the year 1758 and the end of the nineteenth century. This herculean task he began in 1890, and with some unavoidable interruptions he has been pursuing it ever since—for most of the time, I believe, practically singlehanded. A wonderful instalment to the end of the eighteenth century was issued in 1902. But every zoölogist will understand how the task has been growing upon his hands during the last century through the almost appalling activity of naturalists and of what some irreverent persons call species-mongers. Centenarians are common enough in these days, so that no doubt many now living will be able to benefit by the use of his concluding volume.

6.—In the meantime Dr. Schulze has in hand the more manageable endeavour to deal with the names of genera and subgenera, but not those of species, from the same starting-point down to the end of 1910. With this limitation he hopes that his work will be completed within three or four years. It is natural to reflect that for the first forty-three years he has at command Mr. Sherborn's published volume. But in return Mr. Sherborn will, I imagine, derive some assistance from Dr. Schulze's work, since a generic name is a sort of sign-post for the discovery of specific descriptions. The original estimate for the number of references that would be required in the "Nomenclator" was one hundred and fifty thousand. That was subsequently raised to two hundred thousand, and with the progress of the work it is thought that even that number will be exceeded. To make sure that nothing is omitted which should be included in the animal kingdom, either living or lost, there will be some thousands of references to the Protista, in the uncertain borderland between animal and vegetable life. Every reference is to be verified afresh. Nothing is to be taken for granted. But if anyone thinks that the work is being

carried on in any narrow-minded spirit of national rivalry, that is an entire misconception. So far as their services can be obtained, the most eminent specialists in each division and subdivision of the subject-matter are being employed. They belong, not only to Germany, but to Austria, Hungary, Denmark, Norway, Sweden, Russia, England, Scotland, France, Belgium, Switzerland, Italy, and the United States of America. This, as may be supposed, involves a laborious correspondence, much editorial supervision, and, occasionally, the solving of difficult conundrums as to whether a name is really generic, though entered by its author under some other heading. But the partnership with a dozen different countries does not tell the whole story. The division of labour actually extends to more than a hundred collaborators, and still there is room for others. A modest honorarium is offered of twenty shillings for a hundred references. With a total of two hundred thousand, which is the same as two thousand hundreds, you see that this single item of expenditure absorbs two thousand pounds. Perhaps it may seem an easy thing to earn a sovereign by copying out a hundred references. I cannot speak from experience. But to judge by the sport which I have had from time to time in hunting down a single generic name to its source, any hope of making a living out of such pursuits might be compared with the expectation of a man who rents a salmon river in some favourite locality, intending to pay the rent and make a profit out of the fish which he catches. It is true that in any one of the groups—about five hundred in number—into which, for this purpose, Dr. Schulze divides the animal kingdom, for the specialist a good many of the references will be readily attainable. But anyone who has ever dropped a coin knows how the brute metal chooses the most improbable route to hide in the unlikeliest resting-place. Just in the same way intelligent man will enshrine a new generic name in an obscure serial, a book of travels, a faunistic list, or a difficult language, so that the genius of a detective is sometimes needed for tracking it to its lair. This, indeed, has been urged as an argument against the "Nomenclator"; that, after all, it will not attain the completeness at which it is aiming. Human work is rarely perfect. That is scarcely a good reason for withholding the help which is needed for at least trying to reach perfection.

7.—We are bound to remember that, whatever the place of issue, the work, when completed, will be at the disposal of all the world, and that, though all zoölogists may for one reason or another need its assistance, very few of them will need to purchase it. Hence, to those who have borne the toil and anxiety of the publication, there is no prospect of any financial reward. If Germany is a wealthy empire, so, also, is Great Britain. Each, also, has some wealthy naturalists. Yet it would scarcely be an exaggeration to say that they are wealthy, not because they are naturalists, but in spite of it.

8.—Far be it from me, however, to repine at the conditions of zoölogical study. It may well be content with its own fascinations, and, in connection with my immediate object, I cannot forbear to mention the pleasure of genial correspondence, sometimes ripening into personal friendship with those of kindred pursuits in many nations. Every tiny thread of concord in this jealous world ought to be welcomed for the sake of its example.

9.—To conclude, then, consider the advantage of having all these laboriously verified references gathered, at no distant date, into a single storehouse; consider how largely our British societies, by their collective industry in systematic zoölogy, will have augmented the cost of preparing and printing this great record; consider the very large number of members interested in the subject, who compose those Societies, established, not only in London, but throughout the Empire; and on these reflections should not the hope be founded that we may eventually claim to have taken a chivalrous interest in the progress, and borne a substantial share in the expenses, of the "Nomenclator Generum et Subgenerum"?

The British Association has contributed, in two grants, £150. Individual donations, in response to a circular issued by the Council of the Linnean Society, are as follows:—

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Further donations to the "Nomenclator Fund" will be gratefully accepted by the Editors of "KNOWLEDGE," 42, Bloomsbury Square, London, W.C., or by the Rev. T. R. R. Stebbing, Ephraim Lodge, The Common, Tunbridge Wells, and lists of subscribers will from time to time be published in this magazine.

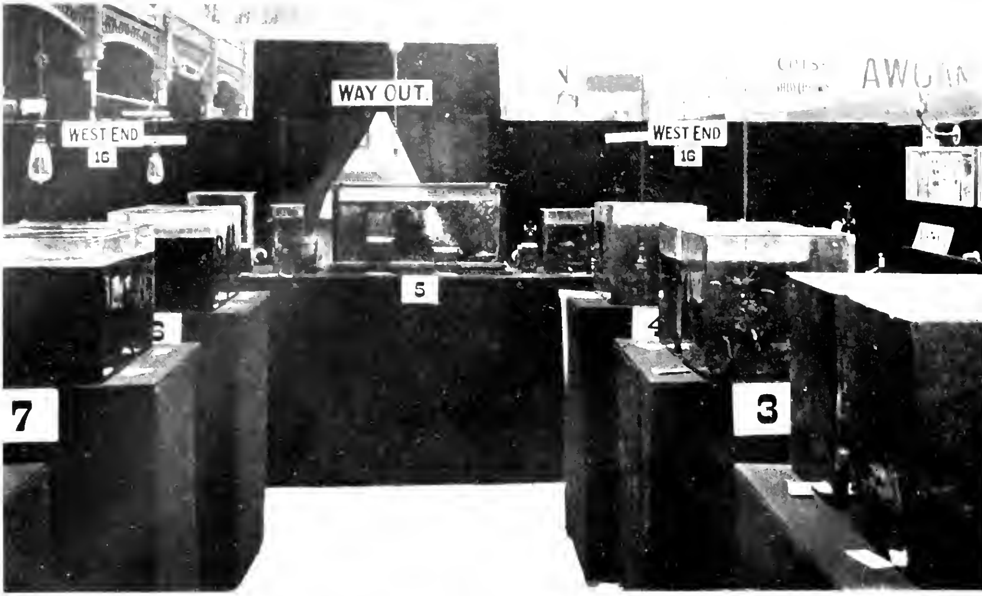
PORTRAITS OF GILBERT WHITE.

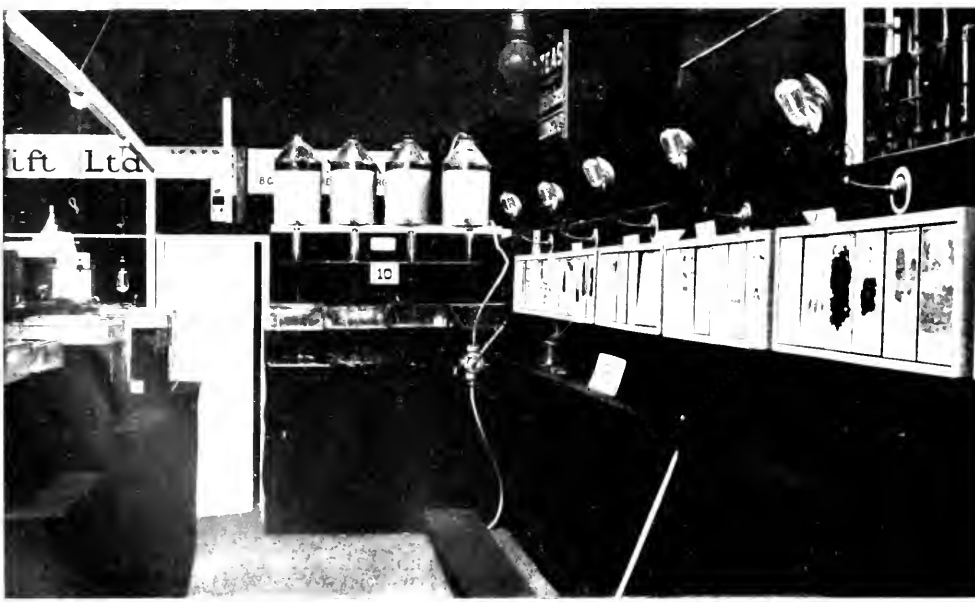
IN the April number of *The Selborne Magazine* an account was given of a copy of the first edition of Pope's "Iliad," in six volumes, which was given by the poet to Gilbert White of Selborne in 1743, on the occasion of his takening the degree of B.A. It was picked up at a sale at Alton by Mr. T. C. Bartlett, and is of particular interest because on the fly-leaves of two of the volumes there are pen and ink portraits. The first is labelled "Portrait of Gilbert White penned by T. C." (see Figure 241), and the other (see Figure 242), though it has above it the initials G.W., is not described. Mr. Rashleigh Holt-White in an article in *The Field* for June 6th accepts both portraits as being those of Gilbert White and expresses the belief that they were drawn by Thomas Chapman, of Trinity College, Oxford, afterwards Gilbert White's colleague as Senior Proctor. The volumes have recently been purchased by the British Museum, and we are able to reproduce photographs of the portraits which the authorities kindly allowed the Secretary of the Selborne Society to have taken.

[illegible]
Sketch [illegible]

[illegible]
Sketch [illegible]

PEN AND INK PORTRAITS [illegible] WHITE FROM THE [illegible]
OF [illegible] ILIAD.





and Mounted Specimens

MUSEUMS AND EDUCATION.

By WILFRED MARK WEBB, F.L.S.

(Continued from page 156.)

THE series of articles dealing with Children's Museums is here brought to a close with a paragraph on Botany, and some details with regard to the frames for mounted specimens and aërators for marine aquaria.

As was indicated at the beginning, an actual illustration was prepared, and was shown under the title of the Children's Museum at the Children's Welfare Exhibition, held at Olympia in April. Two photographs, showing details of the exhibit, are reproduced in Figures 243 and 244.

(2) BOTANY.

As the tendency is, or has been, to emphasise the outside of flowering plants, a set of specimens (most of which in the ordinary course of events would find their way to a rubbish heap), showing that a plant has a skeleton, is of importance. Another point of general, as well as of horticultural, interest is the way in which a tree heals its wounds, and the curious way in which the honeysuckle becomes imbedded in the stem of its host can be understood more easily when the way in which wounds heal is known. In this connection also the characteristics of special orders and groups can be demonstrated, and we may have seedlings and flowers dried in sand, collections of fungi, mosses, and what not, on the lines that have already been laid down.

Going outside the scope of the present paper, various minerals and geological formations can be elucidated. We have already pointed to an ethnological collection, while another—something on the lines of the historical section of Sir Jonathan Hutchinson's Educational Museum at Haslemere — could also be elaborated; though here portraits, drawings, and prints might have to supplement natural objects to a considerable degree.

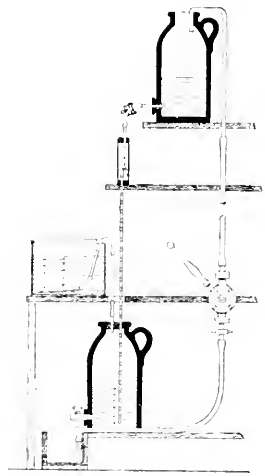


FIGURE 245. A simple aërator for marine aquaria.

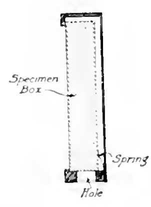


FIGURE 246.

CONSTRUCTION OF THE FRAMES.

The frames in which the glass-topped boxes are contained are so made that any single box can be removed in an instant for examination, or easily replaced by another. Figures 246 and 247 will speak for themselves. The frames have been gradually brought to their present state of perfection, and the design has been registered.

It is obvious that by the use of these frames, which are uniform, a museum can gradually be built up.

AERATORS FOR MARINE AQUARIA.

Figure 245 shows a simple method of aërating marine aquaria by means of two six-gallon stoneware jars, one above the aquarium and one below. Fresh water is allowed to drip into the glass lamp chimney, the flow being regulated by a pinch cock. As the water goes down the tube below, which is not quite underneath the upper one, it carries air with it into the lower jar, and after a short time the air is forced out, and goes into the aquarium, passing first through a piece of cane, which breaks it up into small bubbles. When the lower jar is full, and the air-tube is disconnected where it passes over the edge of the aquarium, the tap is turned on; water flows into the trough, from which it is easily pumped up into the upper jar again by means of an inexpensive semi-rotary wing pump.

It is convenient to set up several aquaria, each with its pair of jars, and the lower ones can be discharged into the same trough. A fixed pipe runs from this to the pump, but the one leaving the pump can be dropped into the neck of any of the upper jars. Just over one minute is the time spent in the pumping up the contents of a jar.

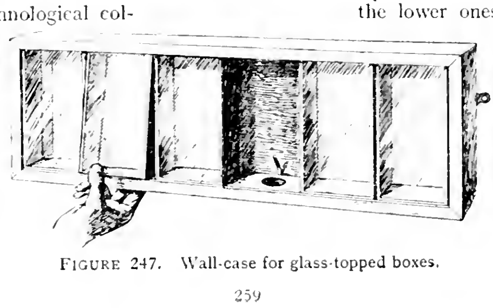


FIGURE 247. Wall-case for glass-topped boxes.

CONTINUITY AND X-RADIATION (WITH SOME NEW EFFECTS).

By W. F. D. CHAMBERS, B.A. (Cantab.)

The interest of the x-rays for those who have not especially studied them must be considered to fall under two heads: first, the light which they throw, or may hereafter throw, upon the structure of matter and the theoretical bases of dynamics and mechanics; and, secondly, the practical possibility interests in any way; for what, after all, *is* matter?

Some philosophers would invite us to reply to this question in terms such as these. Matter is an affection of special sense-organs, which are stimulated simultaneously or in succession. But what do we mean by "sense-organs," and what by being

Figure 248. Fan-formed model made in sheet materials.
a to *bd*: Each edge shows fine lines.
bd to *o*: These lines disappear and a black band appears from *b* to *o*, and corresponding white band from *d* to *o*.
Point of maximum intensity at *o*.

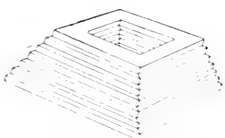


Figure 249. Truncated step pyramid hollowed pyramidically, made in firm sheet cardboard (diagrammatic).

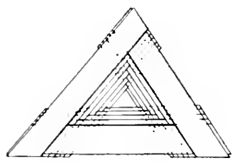


Figure 250. Triangular model of paper strips superposed stepwise, the strips produced.

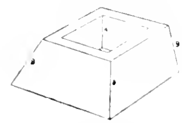


Figure 251. Diagram of hollow pyramidal model.

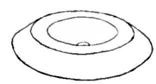


Figure 252. Hollow conical model in ebonite.

of their application (by way of concentration or otherwise) to the problems of diseased tissues. I shall briefly deal with both these questions, and point out what we believe to be a possible line of advance in radio-therapy.

As being probably the swiftest known form of radiation, the x-rays (and γ-rays of radium) enter into competition with light itself, as representing velocities utterly beyond human conceptional powers. And it is still undecided whether that which moves is to be more fittingly described as a series of discontinuous pulses through a stationary medium, or as a material doublet, or β-ray, consisting of positive and negative elements of electricity. Whatever they may prove to be, however, the recent course of research has greatly strengthened the case for their affinity to light, so that if they should turn out to be material, or at least corpuscular, light itself is probably of the same character. But the reader may ask how the solution of this problem would advance human

excited *simultaneously*? The very use of these vague phrases betrays our ignorance of the elements of the mystery, for they imply *almost* * necessarily a something independent of the organs competent to do the excitation work.

Again, there are probably few who do not admit that when one of our senses supports another in the observation of some phenomena, the case for its veritable existence is stronger than when one sense pronounces alone. But this takes us a very little way. For the senses, as a rule, register different kinds of impressions; only in a few cases (as where the tactile sense supports the stereoscopy of the eye in ascertaining the rotundity of a three-dimensioned object) do they bear consentaneous witness to the world around. We do not both hear and see the phenomena of a thunderstorm. We *hear* the thunder and *see* the lightning, so that the testimony of a connexion is never free from some discrepancies.

It is upon considerations such as these that the latest speculative theory in physics, Einstein's

* Solipsists would probably suggest that a species of self-induction (as when a man *damps down* his own anger) may be responsible for all phenomena, including matter and its cause.

theory of the Relativity of Time, is founded, and it tries to answer the question, "What constitutes the simultaneous witnessing of phenomena?" The theory begins by throwing all our cherished common-sense and obvious judgments to the winds. According to its exponents* we *must* doubt that if we take a measured distance from A to P, and another distance from P to Q (both these distances being measured along one and the same straight line), the result is a mathematical sum at all. The answer is not $ap+pq$, but perhaps is fundamentally, and for ever, what is called an inequation, *i.e.*, the Universe is everywhere unintelligible and incommensurable. But, on the other hand, we are not obliged to follow these doubts, founded though they be upon refined experiments upon aether-matter reäction and energy distribution in atomic fields. We may say that space-perceptions, though not additive, are yet exponential, or multiplicative, *i.e.*, a *specific* logical geometry attaches to them, although the results in all sciences contain something more than existed before; more than the components contain. In other words, there is a kind of "special creation," a springing into existence *de novo*, in each of our sense-organs, or in the particles they perceive.

"Time will doubt of Rome," wrote Byron, but even he could scarcely stretch his imagination to the point of doubting Time itself; and yet this is what the Relativity principle invites us to do. Events are not "simultaneous" unless a stop-watch near the moving object (suppose we are observing the occultation of a star) confirms a stop-watch near the observer. Nor is this sufficient. The observer must not be himself moving relatively to the object observed; he must, in the one case where a reliable criterion exists, be situated at a fixed centre of gravity between two stars revolving round it, and transmitting to him *instantaneously* the impressions of their motion. It is a further deduction that when two trains are "moving" side by side at the same speed, the apparent rest produced on the senses of an observer in one of them might be real rest, but that such *coincidences* with our present senses cannot occur. There may be a static or motionless world underlying the phenomenal.

A less probable paradox doubts also the identity of energy observed in different systems. If several observers visualise (the author quotes the *ideas* from Mr. Campbell, and accepts no responsibility for the illustrations) a rifle-bullet in flight, each observes only the energy *in his own system*. The system Earth-Moon being different from the system Earth-Mars, an observer on the Moon perceives a motion of the Earth actuated by a different energy, as well as over a different arc, from that seen by the Martian; and yet, though there were infinite numbers of observers, the energy observed is finite.

The principle of introducing the "personal equation" into the Newtonian dynamics of relative motion, thus changing the "equal and similar arcs," and problems of two bodies into systems of three, was discussed by the present writer in 1900,† before Einstein galvanised the paralytics of a belated orthodoxy; but it is a wholly different thing to make this a ground for discarding a mechanics and a symbolism (the differential calculus) which only require extension. Thought, at the point of vantage, cuts up motion into stationary "quanta," and continuity is to be sought beyond and above the planes of material energy. No competent philosopher can suppose for a moment that it does not exist there, since concatenated thought surely exists here.

To sum up as shortly as possible. The Relativity philosophy, if expounded by those who seek nothing beyond undiscriminating novelties, is that of in-coördination, dislocation of the senses, pluralism, lawlessness, the extinguishment of the idiosyncratic and the unique.‡ Developed with due regard to its inevitable pivot of certainties beyond phenomenal fluxion, it will become the most powerful solvent of prejudice, and monopoly, to "close the interests of all."

But how does this bear upon the problems of the x-radiation, and why is it that the advocates (like Sir Oliver Lodge) of the old Aether theory are so anxious to retain their grasp upon *material* continuity, which they see slipping through their fingers?

Continuity is the last support of method in science, the last hope of constructive mechanics. With the elements of light and electricity material, and matter *merely* a function of speed, and no independent variable, or independent constant on which they may depend with any sense of certitude, phenomena become a fantastic and inconsequent dance upon a background of nothingness.

It is therefore of profound consequence to human destiny what light, what x- and γ-rays may turn out to be, and to do. They lie upon the border-line between Matter and Aether; to paraphrase Sir Oliver Lodge, the electron has now become the engine of discontinuity, red ruin, and the breaking up of laws. In our view, continuity surely exists, but it is not to be sought on physical or substantial planes; it is the Infinite Binding Power of mental states; it directs the aspirations of the Finite across the invisible bridge of the Unconscious. It has now been shown by Mr. Rankin and the writer that x-rays with a theoretical "wave-length," or orbital diameter, between 10^{-8}

* "Modern Electrical Theory," Norman Campbell, 1913.

† The spiral law of organism.

‡ It appears at first sight to lay stress on the individual, but in attacking Order it withdraws his rights.

and 10^{-9} centimetres take notice of so-called non-crystalline bodies. But the limits of systematic molecular arrangements have not yet been found. Colloids may be crystalline, crystals may exist from absolute zero to temperatures of the hottest stars. Indeed, it appears that something answering to the release of the element helium from the system of the radium-atom takes place in all gases, this enfranchisement being effected as if by spontaneous volition at critical points only. For such action could be foreshadowed in a preformed mechanism, as a clock is made to strike at a given time.

In former communications (*Nature*, June 19th, August 14th; *Röntgen Journal*, "KNOWLEDGE," October, 1913, and so on) we showed that effects simulating diffraction and polarisation of light can be obtained with *x*-rays falling on metallic bodies. Black and white bands appearing, as in illustration (see Figure 253), on a short exposure, without the rest of the features of the solid models (placed normal to the rays), indicate the special quantity, intensity, or efficiency of the rays along these lines, or at least they evidence the fact that these uniform bands cannot be due to secondary or excited radiations. Secondary radiations are supposed to be equally produced in all directions. The connexion of the white and black bands, and their mechanical separation by the use of models laminated spirally and fanwise, has, we believe, never been shown before, and it is seen with a great variety of substances—ebonite, celluloid, paper, paraffin-wax, chalk, mica, and various metals. In fact, given the conditions, we believe the effects are perfectly general. The use of the fans (see Figures 248 and 258) is to demonstrate that, with *individual* thin strips, the bands are exceedingly narrow, visible only under the microscope; but as the strips approach the point of divergence, at a certain distance a centimetre or so from the origin, the black band begins to show visibly broader *at the foot of the steps*, whilst a white band of corresponding breadth makes its appearance at the top. This suggests both a shift of the beam as a whole and a summation. There appears to be an optimum breadth for the steps, somewhere near one hundred to the inch, or about ·3 millimetre per strip.

We have used bulbs of all hardnesses, but a soft-radiation of 1 to 1·5 milliamperes is found to give the best results. The standard distances have generally been 50 centimetres between the obstacle and the anticathode, and 10 centimetres between the former and the plate. Reversing the position of the step-models (see Figure 256) towards the rays, and changing the angle of incidence, does not destroy the effect; indeed, with angles of forty-five degrees well-marked broad black and white rings are obtained. When the supposed diffraction of *x*-rays was observed by Sagnac and others in early days (1897), and recently by Laue, Friedrich, Barkla, and Bragg, screens with apertures, which themselves produce in a small amount these edge-effects, were employed. Our experiments have been free from this objection, since no screen whatever has interrupted the rays on their path from the glowing spot supposed to be their origin on the anticathode to the model. With apertures a fraction of a millimetre wide, we believe that the edge-effects would amount to quite fifty per cent. of the rays passing through it, and we even surmise that the two "peaks" of intenser radiation (tested by electroscope) may be related to this effect. These peaks have been observed by Bragg and Mosely in a great number of elements, and attributed to the crystals reflecting the rays. In our view, they may be composite—heterogeneous—a part being produced by the apertures.

Friedrich, who obtained haloes nearly at the same time as ourselves (vide *Nature*, June 13th, 1913) on passing the rays through paraffin-wax, after traversing two metal screens, attributes them to the action of atoms inside the crystals, and speaks of a possible polarisation. He describes the phenomena as of "great interest and importance." We have found that once the rays have been changed in this way, the black bands, at all events, refuse to be changed again.

It was an obvious course to construct solid models, built up with strips, and presenting narrow steps at the edges to the radiation, and to compare these with similar models having plane surfaces. Then the surprising fact appears that the bands are still there, as though even a plane surface acted like steps, and in addition to them the sloping interior and exterior dihedral angles are marked by broad bands—white if a pyramid surface is presented to the rays, black if a similar model is made hollow—and it appears to be a condition of the effect that the exterior and interior surfaces shall not be parallel. This may be expressed thus. When *x*-rays fall upon the sloping surfaces of solid bodies they produce a black or white band at the edges, according as the dihedral angle (*i.e.*, the angle between two surfaces) is greater or less than one hundred and eighty degrees. This would be a natural consequence if we conceive the rays being generated *at great speed* on the surface of a rapidly expanding cone and following a spiral course, so as to strike nearly all points of a hemisphere. The amount of discontinuity evidenced by intensity difference in azimuth (Friedrich, *Phys. Zeit.*, April 1913) and in direction sixty degrees from the normal (Kaye) is surprisingly little. It is also consistent with the hypothesis that the rays may be thus divided into two main types of radiation, evidenced by the black and white bands. It is also of interest to remember that, before the undulatory theory was even born, Newton supposed that his particles were effected near the edge of matter by some force causing them to be deflected into convolutions, and sinuous curves, a repulsive force which may outpace gravitation (as in the

FIGURE 253.

FIGURE 254.

FIGURE 255.

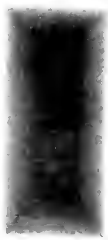


FIGURE 256.

FIGURE 257.

FIGURE 258.

FIGURE 259.

FIGURE 260.

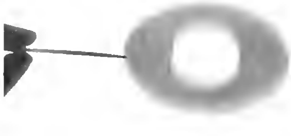


FIGURE 261.

Pl[illegible] to rays, alternating semi-[illegible].

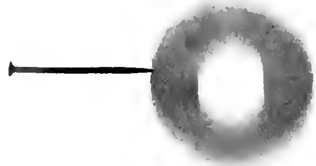


FIGURE 262.

Plate para[illegible]l to ring, alternating semicircles.

From an ebonite ring of rectangular cross-section. Rays incident at 45°.

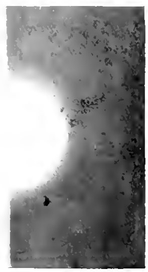


FIGURE 263.

FIGURE 264.

From a conical well, made of paper, showing a black ring at the bottom and white ring at the top.

FIGURE 265.

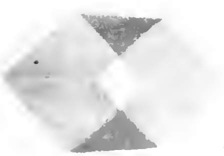


FIGURE 266.

FIGURE 267.

[illegible] white band [illegible]

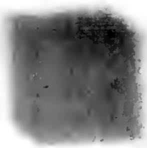


FIGURE 268.

FIGURE 269.

From rhomb of glass with 56 laminae.

N[illegible] photographs the [illegible] white are reversed.

Moorhouse comet, Eddington), if, indeed, the latter be not a mere residual or differential of two forces of infinite potential powers. They might thus be responsible for the ubiquitous tendency to rotation and "spirality" which we observe in nature. That the Newtonian mechanics require extension is now almost universally admitted; but even when it is stretched to the uttermost to conceive of mass variable with internal energy and *vis a tergo* acting along helical lines of force, it is difficult to see how it can conduct the human mind to infinity beyond its reach.

In the earlier experiments (on single laminae) a bulb having a very fine focus was used, definition being of great importance. The present results were obtained with a large water-cooled Müller tube, with a platinised nickel anticathode. The current was kept constant by means of variable resistance in the primary, 1 to 1·5 milliamperes being commonly used.

Since the above article was written, it has been brought to our notice that the black band near bodies was observed as early as 1896 by the President of the Röntgen Society (Professor Porter) and Mr. Morris. The importance of this was lost sight of in consequence of the work with shields by Haga and Wind and others, which were supposed to be conclusive against refraction. *Ordinary* refraction, or diffraction, the effect certainly is not. Upon the hypothesis of a medium, such as aether, composed either of spent electrons, or as a continuous and very dense stratum near bodies, it is to be noted that the present is not an effect of *internal* action of matter upon bound aether, but is external to matter. In fact, it is evidence such as the experiments on aether drug (Mitchelson, Morley, Lodge) were designed to obtain, but without result. Moreover, these effects cannot be attributed to internal reflection, as suggested by Friedrich and Porter, since this would give opposite effects to those now obtained, viz., the black bands would appear *within* the shadow.

In a more recent experiment we have shown that the black band can be *separated* from the white in such a way that the two half-hoops of a ring (ebonite, with *rectangular* cross-section) show as white and black *semicircles*. This is true for all positions of the ring except the limiting angles, *i.e.*, 90° and 0°, and is highly significant of the fundamental duality of the rays, especially when taken in connexion with the fact that electroscopic tests for the black bands have given a 7 ± 2 increase over the normal radiation from the same aperture ·3 millimetre in width (see Figures 261 and 262).

The models and negatives actually used were exhibited at the Annual General Meeting of the Röntgen Society on June 9th, and can be seen by appointment at any time on application to the Medical Supply Association, Gray's Inn Road.

THE COMING ECLIPSE AND ITS PREDECESSORS.

As astronomers are taking so much interest in the coming total solar eclipse of August 20th to 21st next, it may be of interest to know that by the end of the present century this series or family of eclipses will entirely run out, that is, will cease to produce total eclipses; the last total eclipse taking place on October 3rd, 1986, which will be the fourth return of the one of August 21st next. The first total eclipse of this series took place on June 11th, 1211, and was visible in the southern hemisphere. The enclosed computation of the same is by the method of the late Professor Newcomb, in his work on "Recurrence of Solar Eclipses." I have computed the track of central eclipse of all of the eclipses of this series, from the one of next August to the last one of October 3rd, 1986. Within the last hundred years or more there have been many fine eclipses (all descending node) of this series. The total eclipse of June 16th, 1806, which was visible in the United States, was total in New York State and Northern New England. Dr. Nathaniel Bowditch, translator of Laplace's "Mécanique Céleste," observed it at Salem. He did not mention the prominences and scarcely mentioned the corona. He merely says: "The whole of the Moon was then seen surrounded by a luminous appearance of considerable extent, such as has generally been taken notice of in total eclipses of the Sun." The total eclipse of July 8th, 1842, one of the most famous ones of the past century, belongs to this series. Mrs. Todd, in her interesting little book on "Total Eclipses of the Sun," says of this eclipse: "While the eclipse of 1842 marks the dawn of a golden age in physical research upon the Sun, investigation proceeded slowly." From 1842 to the present time eclipses have contributed more to the physical side than to astronomy of precision. The next return of this series was the eclipse of July 18th, 1860. It was at the time of this eclipse that De La Rue demonstrated that the prominences were solar in their origin. The next return took place on July 29th, 1878. This eclipse attracted the attention of astronomers all over the United States. The Moon's shadow entered the United States in Washington Territory and Oregon, travelled south-east over Yellowstone Park, Wyoming, Colorado, into Texas, and left the Earth in the Gulf of Mexico near the West Florida coast. The writer observed this eclipse from Fort Worth, Texas, he being a member of a party of five who journeyed there for the special purpose. The other members of the party were: Dr. Leonard Waldo, then of the Harvard College Observatory; Professor Robert W. Willson, then and now of Harvard College; Professor J. K. Rees, then of Washington University, St. Louis; and Mr. W. H. Pulrifer, of St. Louis. The writer observed the reversion of the Fraunhofer lines at the instant of totality, and saw and measured the position of the 1474 line in the yellow-green part of the spectrum. Dr. Waldo had charge of the photographic work. Professor Rees observed with a three-prism spectroscope, and Professors Willson and Pulrifer did visual telescopic work. Clear skies favoured all of the observing parties on the central line from Oregon to Texas on that day. This eclipse took place during a minimum period of sunspots, and the regular type of corona was seen at that time. The next return took place August 9th, 1896, visible mostly in Northern Europe, and many of the observers were defeated by clouds and generally bad weather. The next return will bring us to the eclipse of August 21st this year. This should be a most interesting eclipse, especially so now as we are, apparently, very near the end of a very long and drawn-out period of minimum sunspots.

F. E. Seagrave.

Boston, U.S.A.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

Professor Lowell was present at the May meeting of the British Astronomical Association, and gave some further particulars of his recent researches on the rotation period of Mars. He showed that the observations of the last century agree well with his new value of $24^h\ 37^m\ 22^s{\cdot}57$. The larger values previously accepted rest mainly on the sketches of Hooke and Huyghens in the seventeenth century. It would appear that too much weight has hitherto been given to these, in view of the very inferior instruments of that date and the inexperience of the observers in planetary delineation. It will be remembered that Mr. R. A. Proctor, the founder of this journal, contended strongly for the value $22^s{\cdot}72$, but he would probably now admit, in the face of the cumulative evidence, that this value must be too great.

Professor Lowell also observed that the experiment had been made of viewing Mars with the new forty-inch reflector (which was designed, not for planetary, but for stellar work), and that at moments of the best definition the network of streaks could be seen under the same aspect as with the twenty-four-inch refractor. Both he and Professor Pickering agree that a very large aperture can only be used with advantage for planetary work when the atmospheric conditions are practically perfect.

Much work has also been done on Saturn at Flagstaff. The variability of several of the satellites has been measured; the period of rotation appears to be the same in all cases as that of revolution, so that our Moon is not singular in this respect. Small corrections to the distance and motion of Mimas and Enceladus were found, and the existence of several faint divisions in the rings was verified, including that of Encke. The positions of these gaps were found to correspond with periodic times of revolution synchronous with that of Mimas; they are analogous to the gaps in the asteroid zone at points where the period is a simple fraction of that of Jupiter.

Professor Lowell also stated that they had been able to observe Venus fully illuminated within a few degrees of the Sun, and that the observations supported the identity of its periods of rotation and revolution. He considered that the high albedo arose, not from cloud, but from minute dust particles in suspension, which would give a still higher albedo than cloud, but would at the same time act as a veil rendering it very difficult to see the surface details. I may note that some recent observations by members of the Société Astronomique Française, reported in their Bulletin, also support the slow rotation of Venus.

Work is also being done at Flagstaff on the photography of the spectra of nebulae. Allusion has already been made in these columns to the continuous spectrum of the Merope nebula in the Pleiades and the great radial velocity found for the Andromeda nebula. Professor Lowell told us that he had just heard by telegram of the detection of rotational movement in a nebula in Virgo. He supposed this to mean a well-known planetary nebula that presents some resemblance to the figure of Saturn; but further details on that point and on the nature of the evidence of rotation will be sent by mail. Work on the spectra of planetary nebulae is also being carried on by Professor Wolf at Heidelberg, and he received the gold medal of the R.A.S. last February for this and other work. Some of his exposures extend to seventy-two hours, and he also has found evidence of high radial velocity in some of the nebulae examined, which, if verified, supports the idea that they are external universes.

COMETS.—Delavan's Comet has been hidden in the Sun's rays since April, but may be expected to emerge towards the middle of July. Mr. F. E. Seagrave has computed the following orbit: Perihelion passage, 1914, October 26·6731 G.M.T.; Omega, 97° 26′ 31″; Node, 59° 9′ 33″; Inclination, 68° 7′ 35″; Log. perihelion distance, 0·04375. The following ephemeris is for Greenwich midnight:—

Date.	R.A. h. m. s.	N.Dec. ° ′	Log. r.	Log.Δ.
July 22	5 36 40 ...	35 42 ...	0·2676 ...	0·4106
,, 30	5 58 36 ...	38 18 ...	0·2457 ...	0·3837
Aug. 7	6 24 0 ...	40 59 ...	0·2236 ...	0·3553
,, 15	6 54 24 ...	43 44 ...	0·2005 ...	0·3257
,, 23	7 31 14 ...	46 22 ...	0·1770 ...	0·2958
,, 31	8 15 43 ...	48 35 ...	0·1534 ...	0·2669

On July 29th the comet will be near Theta Aurigae; it will remain in Auriga till mid-August, when it will enter Lynx. It will then be above the horizon all night, but the best time for observation will be two or three hours before sunrise. In September it will traverse Ursa Major, and in October Boötes. It is difficult to give a prediction of its brightness, but I anticipate that it will become faintly visible to the naked eye in September. Its large perihelion distance is the only reason for doubt as to its becoming a fine comet; but the case of the great comet of 1811 shows that this is not an insuperable objection. Professor Pickering has pointed out that its orbit belongs to the class which he designates by the letter "Q," a class to which many conspicuous comets have belonged.

PROFESSOR BARNARD'S OBSERVATIONS OF NOVAE.—Professor Barnard has published another set of interesting notes on the Novae of recent years observed with the Yerkes Refractor. Last October he found that Nova Geminorum 2 (Enebo) had a focus of five or six millimetres greater than normal; but in January and February of this year the focus had returned to normal, and the aspect was that of an ordinary white star; it was one and a quarter magnitude brighter than the faint star 12″ north of it. The great Perseus Nova of 1901 underwent similar changes. The focus is now normal, and it appears like an ordinary white star, getting very slowly fainter. Last February its magnitude was 12·4. Nova Geminorum 1 (Turner, 1903) was of magnitude 16·8 last February. It is still fading slowly, but Professor Barnard expects that it will be visible in the forty-inch for at least another year.

EXTRACT FROM A LETTER ON COMETS BY M. FÉLIX DE ROY (Honorary Secretary Astronomical Society of Antwerp). — "Next December it enters the southern sky, and rapidly recedes from Earth and Sun, becoming invisible for the northern observers. If the comet does not brighten unusually, it will just be visible to the naked eye in October next, and the probability is that its apparition will not be a startling one. The curious fact with this comet, as pointed out by M. van Biesbroeck, is, however, that it is one of the cometary bodies with the largest *intrinsic brilliancy* as yet observed. In December last its magnitude was 10·7, and it could be observed in a small telescope. It was then at the distance 3·6 of the Sun (distance 1 = radius of Earth's orbit). At this same distance Halley's Comet was 16·3, and could only be observed with the most powerful photographical reflectors. The *unit magnitude* of Comet Delavan (as seen at distance 1 from Sun and Earth) is 5, and, since ten years, only four comets showed an equal or a greater proper brilliancy, *i.e.*:

1910.	(*a*)	Johannesburg	...	4	magnitude.
1904.	(*a*)	Brooks ...	...	5·0	,,
1911.	(*g*)	Beljawski ...	...	5	,,
1912.	(*a*)	Gale... ...	...	5·0	,,

For Halley's Comet this intrinsic brilliancy was only 10, for Morehouse's Comet (1908 *c*) 6·2, for Westphal's Comet (1913 *d*) 8·7. If Delavan's Comet does not become

unusually or irregularly fainter, its magnitude will be as follows:—

Date.	Distance from Sun.	Magnitude.
1916, July 1	7	12·9
1917, ,, 1	10	11·7
1918, ,, 1	12	15·5
1919, ,, 1	14	16·2

One can therefore expect that this comet may be still observed with the great Cape reflector as late as the summer months of 1919. It will then wander at one thousand three hundred and one million miles from the Sun, and, if an observation may be thus obtained, Comet Delavan *will have been observed in seven consecutive years*, an unusual, and perhaps unique, feature in observational astronomy."

I would remark that the writer of this interesting note does not seem to have allowed sufficiently for physical change when the comet approaches perihelion. I shall be surprised if it does not become brighter than the sixth magnitude.

Another naked-eye comet was discovered in mid-May by M. Zlatinsky at Mitau, near Riga: it was for a few days a conspicuous object in the evening sky, but it soon ran to the south, and is now out of our reach. Its orbit resembled those of 1790 III (Caroline Herschel) and Quenisset's of 1911; it thus offers another example of a family of comets having almost identical orbits.

Kritzinger's Comet has also been an easy telescopic object in May and June, and may still be visible during July, being of the ninth magnitude. The following ephemeris is for Berlin midnight:—

Date.	R.A. h m s	N.Dec. ° ′	Log. r.	Log. Δ.
July 1	22 14 36	44 45	0·1043	9·8185
,, 9	22 28 20	44 4	0·1199	9·8332
,, 17	22 37 52	42 48	0·1377	9·8456
,, 25	22 43 40	41 0	0·1568	9·8562

BOTANY.

By PROFESSOR F. CAVERS, D.SC., F.L.S.

DROUGHT RESISTANCE IN FERNS.—Two interesting papers have been published recently on the adaptations of various ferns to resist drought. Ferns as a class are, with conspicuous exceptions like the bracken, confined to shaded and moist habitats, but where necessary they may show marked adaptations for life in places where the water supply is scanty or liable to great changes. Schaede (*Beitr. zur Biol. d. Pflanzen*, Bd. 11) points out that, while in a general way the methods adopted to secure protection against strong insolation and transpiration are much the same among ferns as in flowering plants, xerophilous ferns present certain features of special interest. The most striking of these are rolling up of the leaflets and leaf-stalks during drought, and the possession (usually in addition to rolling) of a covering of scales or of wax on the lower side of the leaves. Several xerophilous ferns from various parts of the world were investigated, and some common European species were used for comparison in the experiments made. The scale-covered forms investigated were species of *Ceterach* and *Notochlaena*. The scales were found to act largely by reflecting a considerable portion of the incident light, part of which was absorbed by the brown pigment of the scales, so that in cases where the scales are well developed and closely overlap each other very little of the incident light passes through this covering. In *Notochlaena sinuata* the overlapping whitish scales are mingled with much-branched hairs forming a dense felting. The wax-covered forms examined were Mexican species of *Notochlaena*, *Cheilanthes*, and *Ceropteris*. The wax is secreted by hairs covering the lower surface of the leaves, and forms a coherent covering joining the tips of the hairs in such a manner as to form a membranous canopy, and thus produce an air-still chamber below the leaf—a very effective method of checking transpiration. In *Ceropteris calomelanos* the leaflets do not become rolled up as in the other species with waxy covering, but each leaflet is inserted on the petiole by a broad base, which is decurrent on the petiole, so that the latter has a kind of wing on either side corresponding with the two rows of leaflets, and the cells of the wings are contractile, so that during drought the two rows of leaflets become folded together with their waxy under-surfaces outwards. In the other forms investigated the leaflets simply undergo changes in form. In most cases this consists in an irregular crumpling and folding in the long axis of the leaflet between the veins, the result being that the convex sides of the folds are on the upper side of the leaflet. In *Asplenium septentrionale* each leaflet assumes the form of a spirally wound ribbon, in *Actiniopteris radiata* that of a completely closed tube; in both cases the whole leaf also curves so that the leaflets are placed parallel with the incident light-rays.

Pickett (*Bull. Torrey Bot. Club*, Volume 40) points out that little is known regarding drought-resistance in fern prothalli. The form dealt with, *Camptosorus rhizophyllus*, grows usually on the surface of dry limestone ledges and on detached rocks in stream beds, and since these places are without constant water supply the plants are subjected to brief periods of abundant moisture (during and immediately after rain), which alternate with longer drought periods; hence it becomes a question how plants with a delicate prothallial stage in their life-cycle can secure and retain residence under such conditions. Cultures of mature spores were made, with a view to obtaining information regarding the uniformity of spore germination and prothallial development, the ability of prothalli to resist or survive natural drought conditions, and the ability to survive conditions leading to complete desiccation. The spores of this fern were found to germinate very irregularly, and to have a long, dormant period on the moist soil of cultures, suggesting that they might remain in this condition through the winter season in their natural habitat. Experiments in which prothalli were subjected to dry air without direct sunlight — continuous conditions approximating the average of varying conditions found in nature—showed that the production of mature prothalli under such conditions was possible; while the subjection of prothalli to more thorough desiccation over sulphuric acid, and so on, showed the possibility of surviving the extreme conditions found in nature. The author concludes that the drought-resisting character of the prothalli is doubtless a very effective factor in the adaptation of this fern to its habitat.

PLANKTON (VEGETABLE) OF THE ENGLISH CHANNEL.—Mangin (*Rec. Jub. Sci. du Prof. Le Monnier*, 1913) describes plankton observations made between 1908 and 1912 in the waters near Tatihou on the coast of the Manche peninsula (North-western France); since the depths are very slight (only fifteen to twenty metres) surface plankton alone is dealt with. The volume of the plankton was always smallest in winter, but increases in March and attains a first maximum in May or June, and a second more important maximum in October and November. The plankton is distinguished by great abundance of Diatoms, Peridineae being scarce; between May and August it is homogeneous, and made up of few species, while during the rest of the year it is heterogeneous and varied. The distribution of the dominant species is indicated by a series of diagrams showing the average dates of their appearance, dominance, and disappearance. Of the forty-five Diatom species found thirty are widely distributed neritic forms in temperate regions, and the remainder Arctic forms. The term "neritic" is applied to organisms found in shallow or inshore waters as compared with those of the open deep sea ("pelagic," or "oceanic"). In discussing the relations between the phytoplankton of Saint-Vaast and that of neighbouring regions, the author points out that

from observations made on the opposite sides of the English Channel—off Manche and off Plymouth—one might infer that oceanic species would be continually driven by the currents entering the Channel on to the south coast of England from Land's End to Newhaven, and that the peninsula of Manche would shelter Saint-Vaast (on the eastern side of that peninsula) from this invasion. On the other hand, currents proceeding from the North Sea and impinging on the French coast would extend as far as the Seine Bay, and bring to this region a larger proportion of boreal and Arctic species than would reach Plymouth, some of these species eventually becoming endemic forms. The phytoplankton of Saint-Vaast is thus of a neritic type, sheltered from the invasion of Atlantic forms and open to that of Arctic or boreal forms, some of the latter having become endemic, and thus added to the typical neritic forms of temperate waters.

CHEMISTRY.

C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

THE NITROGEN AND CHLORINE IN RAIN AND SNOW.—Mr. G. H. Wiesner examined twenty-two samples of rain-water and nine of snow, which fell between February and June, 1912, at Mount Vernon, in the United States. The place was a small village, with a population of one thousand seven hundred, and had no manufacturing industries. The average results obtained in the estimation of the nitrogen and chlorine, which have recently been published in *The Chemical News* (1914, CIX, 85), were as follows :—

PARTS PER MILLION.

—	Snow.	Rain.
Free Ammonia ...	3·35	0·931
Albuminoid Ammonia ...	3·84	1·13
Nitrite Nitrogen ...	0·0021	0·0018
Nitrate Nitrogen ...	0·19	0·15
Chlorine	4·7	4·8

It is mentioned that during the period selected the rainfall was fifteen inches and the snowfall twenty-four inches, which was equivalent to two inches of rain. This was higher than the average rainfall for the district.

DISTRIBUTION OF ALUMINIUM IN THE VEGETABLE KINGDOM.—A micro-chemical test for aluminium has been devised by Dr. E. Kratzmann (*Pharm. Post*, 1914, XLVII, 101), and is capable of detecting traces of aluminium in plant-ash and in the sections of plants. It is based upon the fact that on treating an aluminium salt with a solution of caesium chloride and dilute sulphuric acid characteristic crystals of a double salt of caesium and aluminium sulphate are obtained within a few minutes.

By applying the test under the microscope the aluminium crystals may be seen *in situ* in the sections of plants, and it has been shown in this way that aluminium is widely distributed in the vegetable world. Certain plants, such as, for example, *Lycopodium*, *Vitis*, *Symplocos*, and *Anchusa* in particular, are remarkably rich in the element. The so-called "alumina bodies," which have been described as present in the leaves of plants of the *Symplocos* species, were only found by this test in the leaves of *S. polystachya* and *S. lanceolata*.

THE ACTIVE MODIFICATION OF NITROGEN.—Messrs. H. B. Baker and R. J. Strutt have published further experiments which show that the "after-glow that characterises the active modification of nitrogen is not due, as was asserted by Messrs. Tiede and Domcke, to the presence of traces of oxygen (*Ber. d. deut. Chem. Ges.*, 1914, XLVII, 801 and 1049). Thus they have found that nitrogen from which every trace of oxygen had been eliminated still showed the phenomenon, as did also the nitrogen prepared from potassium azide. Moreover, contrary to the statement of Tiede and Domcke, commercial nitrogen from a cylinder remained "active" after having been passed over copper heated to 400° C. to remove any residual oxygen. As a further proof that "active" nitrogen is a distinct modification of the element, there is the fact that it enters into combination with other substances. For example, it acts upon different metals, such as mercury, to form nitrides; while it decomposes certain organic compounds, with the formation of hydrogen cyanide. These results confirm the conclusion of Messrs. Koenig and Elöd, an outline of which has already appeared in these columns.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

RECRYSTALLISATION OF DEFORMED IRON.—The results of an experimental investigation of this subject by Mr. C. Chappell were given in a paper read before the Iron and Steel Institute. Samples of practically carbonless iron were pulled to fracture in a tensile-testing machine, and others had indentations made in them by means of a hardened steel needle actuated by a Brinell hardness-testing machine. The deformed samples were then annealed at different temperatures, and the alteration in the crystalline structure of the metal, as affected by the two variables, degree of deformation and temperature of annealing, studied. Two distinct resulting zones were observed. The first, that of maximum deformation, yielded new crystals not markedly different in size from those of the original material previous to deformation. The original crystals disintegrated and the new crystals grew from the *débris*. The second (outer) zone, in which plastic deformation had taken place to a less extent than in the first zone, was characterised by an enormous increase in crystal size. As regards the temperature of recrystallisation, it was found that the more highly deformed parts recrystallised at lower temperatures than those parts which had suffered less deformation. The examination of cold-drawn wires showed that the deformation produced in ordinary wire-drawing operations corresponds to that of the first zone described above. Attempts were made to obtain coarsening of crystals on annealing less severely cold-drawn wires, which might be considered analogous to the less-deformed outer zone, but were in all cases unsuccessful.

THE COLOUR OF METALS AND ALLOYS.—In an article in *The Chemical World* for May, 1914, Messrs. F. C. Thompson and E. Sinkinson describe a method by which numerical values for the colours of metals may be obtained. The metal sample is polished with emery, and is then photographed through a blue glass screen. The time of exposure, time of development of the plate, temperature of the developer, and all other conditions must be reproduced exactly in order to obtain comparable results. The density of the resulting negative is measured in a Sanger-Shepherd densometer, and the result calculated to a scale in which the colour value for silver is 0, and that of copper is 50. The results obtained by the authors show that an increase of coloration in the metal does give a higher "colour figure," but the method can detect no difference between pure and "standard" silver (silver 92·5 per cent., copper 7·5 per cent.), and is only just sufficiently sensitive to distinguish between German silvers having respectively fifteen and seven per cent. of nickel.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

PERMANENCE OF THE ATLANTIC COASTLINE.—Professor J. Welsch contributes an interesting study of the coastal border of South-western France to the May issue of the *Annales de Géographie*. The section discussed extends from about the river Sèvre to Biarritz. On this coastal

stretch numerous phenomena have been recorded as indicating an alteration of the relative levels of land and sea. Professor Welsch reëxamines such and similar evidence in order to decide whether the coastline has altered within recent time. He dates this " recent " period from the close of the Palaeolithic and before the beginning of the Neolithic.

For the most part the evidence is of the usual nature—raised beaches, old sea cliffs, and submerged peat beds and forests. Many of these, however, are of an older date, Pliocene and Pleistocene. But conclusions regarding the later period with which the paper deals have been drawn indiscriminately from them, and some sifting of the evidence is necessary. When the older remains have been put on one side Professor Welsch finds it possible to explain the facts without reference to uplift or depression of the land. It has been held that in some cases purely local movements of considerable amplitude in both senses have taken place. Such movements are both unnecessary and highly improbable. Much can be explained by supposing that protecting dunes and banks which once held up fresh and brackish lagoons have been removed by marine erosion. Such processes of erosion can be seen to be in progress with similar consequences at the present day. Shifting drifts of sand have exposed old smothered forests in France as they have done in Scotland, and young forests are seen growing on the sand and mingling with the old. There is no proof, it is held, of submersion or of emergence of the land since the Neolithic began, while in the period immediately anterior movements and dislocations certainly took place.

An interesting phenomenon discussed in the paper is the presence of great mounds of oyster-shells at Chauds in Vendée, Les Buttes de Saint-Michel-en-l'Herm. These lie on late marine deposits, rising two or three metres above sea-level, and attain a height of eleven metres. The " buttes " are three in number, elongated rounded hillocks, extending over ·8 kilometre. The true thickness of the deposits cannot be ascertained, but the mounds have been breached to get shells for lime, and are seen to consist almost entirely of oyster-shells with little or no sand or grit and rare shells of other species and genera. These shell banks are different from any that have been described elsewhere on the Continent. The shells composing them have the peculiarity that often the two valves are joined. The mounds cannot therefore be regarded as kitchen-middens, nor are they natural deposits. They are probably the work of man, possibly relics of religious significance like others in the plateaux of Algeria and in America.

THE SEA ROUTE TO SIBERIA.—The development of Siberia, which for a long time was slow, but has quickened of late, promises to be an interesting subject. Minerals, timber, and, above all, agriculture promise to be its most valuable resources, but so far they are almost untouched. Trapping is the only industry carried on in Siberia to supply Western markets. Of recent years the Russian Government has adopted a more liberal and enlightened policy, and in each of the last two years the number of immigrants has been about three hundred thousand. Jonas Lied writes in the May *Geographical Journal* on the resources and development of Siberia, and the article makes fascinating reading. It is followed by a second, by Dr. Nansen, on the possibility of a sea route through the Arctic Ocean. A passage was actually made by the Kara Strait in a " tramp " steamer last autumn, Lied and Nansen being on board.

The navigability of the route seems to vary in different seasons, but to be dependent on circumstances easily determinable. Cold, dry years tend to be followed by close winters and autumns, and mild or moist years by open seasons. Nansen believes that if continuous and systematic observations were made, the passage could be made almost every year, and intelligence of the position and movements of the ice supplied which would make the route practicable at favourable times even in bad years.

FEDERAL CAPITAL OF AUSTRALIA.—In the April and May numbers of the *Geographical Journal* readers will find a physiographic study of the new capital of Australia, Canberra, by Mr. G. Taylor. The article studies the topography of the selected area and discusses its evolution. The suitability of the site is exhibited, and the progress of work in the city is described.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

PILLOW-LAVAS IN THE ANDES.—An occurrence of pillow-lava with several unusual features is described by J. A. Douglas in a paper on " Geological Sections through the Andes of Peru and Bolivia " (*Quarterly Journal of the Geological Society*, April, 1914). It occurs in the Morro de Arica, and is interbedded with Jurassic shales. The pillow structure is first exhibited in a thick flow (one hundred and fifty feet) of enstatite-andesite. The spaces between the pillows are filled up with a black shale or mudstone containing an abundance of *Posidonomya escuttiana* Douglas, which continues for a few feet above the lava. It is succeeded by red, sandy, gypsiferous shales, above which further flows of pillow-lavas occur at several horizons. The whole thickness of the lavas exhibits pillow-structure, and the " pillows " are often more than ten feet in diameter. The lamellibranch shells, found in the black shale between the pillows, are often unbroken and well preserved, and the lava doubtless represents a submarine volcanic flow contemporaneous with the deposition of the shale. The rock differs essentially from many other occurrences of pillow-lava, in the almost complete absence of vesicular or amygdaloidal structures. Furthermore, it is very fresh, with a complete absence of the albitisation which occurs in the spilitic pillow-lavas, and its petrographic character is distinctly of a " Pacific " type. This occurrence adds one more, therefore, to the growing list of pillow-forming rock-types, in addition to the typical spilites.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

CONNECTION BETWEEN THE SUMMER RAINFALL AT HAVANA AND THE WINTER RAINFALL IN THE SOUTH-WEST OF ENGLAND.—At the meeting of the Royal Meteorological Society on May 20th Mr. A. Hampton Brown read a paper on " A Cuban Rain Record and its Application," in which he dealt with the rainfall records of the Belen College Observatory, Havana, for the period 1859 to 1912, and gave particulars of the monthly, yearly, and seasonal rainfall. The average yearly rainfall for the fifty years 1861–1910 is just under fifty inches; but during the past fifteen years there has been a marked tendency to diminished amounts. March is the driest month, with 1·91 inches, and October the wettest, with 6·92 inches, followed closely by June with 6·71 inches. The most phenomenal month was April, 1869, when 22·57 inches was recorded, falling on six days. On the other hand, April, 1896, was entirely rainless. The rainfall year can be divided into two seasons—a wet season from May to October, and a dry season from November to April. During the former 35·36 inches, or seventy-one per cent., of the rain falls, the remaining 14·60 inches, or twenty-nine per cent., being recorded in the dry months. The author has endeavoured to trace the connection between the wet season at Havana during May to October and the precipitation in South-west England and South Wales during the three months January to March following, and he has found that from 1878 onwards, when the first reports for this country are available, an excess rainfall in Havana during May to October was generally followed by a deficient rainfall in South-west England at the beginning of the next year, and *vice versa*. For the eight years 1888–1895, when the rainfall at Havana was continuously in excess, in South-west England the figures with one exception were the reverse.

During the next five years, 1896–1900, there was a deficiency at the Cuban station, and, excepting 1897, an excess in this country. There were many years when the application failed, but the general continuance of the see-saw movement was so persistent that it could hardly be regarded as merely coincidental. The author suggested that the cause of the connection was possibly due to the interaction of the trade winds, the Gulf Stream flow, and the Labrador Current, and thought that if a more definite knowledge of the movements of these were obtained it might be possible in conjunction with the Havana rainfall to work a fair approximation of the probable rainfall for South-west England and South Wales for the first three months of the year.

EFFECT OF THE GULF STREAM ON OUR CLIMATE. —Commander M. W. Campbell Hepworth, at a recent meeting of the Royal Geographical Society, read a paper on the "Gulf Stream," in which he expressed the belief that the warm, relatively high salinity water which undoubtedly exercises an ameliorating effect upon the climate of our islands and upon that of North-western Europe generally is mainly of equatorial origin, and is directly attributable to the agency of the Gulf Stream. He pointed out that air temperature over these islands is modified by changes in the surface temperature in at least three ways: (1) By winds that come from seaward; (2) by the influence of sea temperature upon the course taken by low-pressure wind systems which pass over or near them; and (3) by a diminution of cloudiness.

The temperature of the air is soon modified by the temperature of the surface water over which it passes. When the surface temperature of the north-eastern arm of the North Atlantic is much below the normal, atmospheric pressure over the Iceland-Farœ region has a tendency to increase, and the centres of depressions visiting North-western Europe to be diverted to a more easterly direction, and to pass directly over the British Isles or not far north, and at times even south of their coasts, bringing to our islands much cloudiness and rain. On the other hand, during seasons in which the warm stream extends as far to the north-eastward as its average limits, or still farther north, depressions travelling eastward and north-eastward from the Atlantic pursue paths which take their centres to the north-westward of our western and northern shores, with the result that a mild or comparatively mild type of weather conditions, accompanied by more or less sunshine, prevail.

The association of bright, warm weather in summer with sea temperature above the normal may perhaps be accounted for by the small difference obtaining between the temperature of the air and that of the surrounding sea, the consequent diminution of cloudiness, and corresponding increase of sunshine. In that season, moreover, a diminution even in the quantity of vapour in the atmosphere during the day and following night is attended by a rise in the mean temperature of the twenty-four hours, because the heat the Earth receives by solar radiation exceeds that which it parts with by terrestrial radiation.

Commander Hepworth in conclusion said that "proof may be claimed, resting on a chain of evidence, that many of the climatic changes to which our islands are subject, owe their origin to modifications in the trade winds of the Atlantic, communicated through the agency of the equatorial currents, and its giant offspring, the Gulf Stream."

INFLUENCE OF DUST STORMS ON THE ATMOSPHERIC POTENTIAL GRADIENT.—Mr. W. A. D. Rudge during the past three years has carried out observations at Bloemfontein in the Orange Free State on the daily range of the atmospheric potential gradient. These observations on the high veld show that considerable variations may occur as a consequence of the presence of dust in the atmosphere. The effect of the siliceous dust of South Africa is to lower the normal positive gradient, and, if present in sufficient amount, to reverse it. Wind unaccompanied by dust has very little influence on the normal charge in the atmosphere. The rain which fell during the period under special observation (July to December, 1912) was invariably charged negatively.

MICROSCOPY.

By F.R.M.S.

I.—THE WATER-BEETLE (*DYTISCUS MARGINALIS*). (*Continued from page* 225.)—The spiracles, or breathing-pores, of the Water-beetle are found as oval slits on each segment of the body. These openings have projections from the sides covered with very fine horizontal hairs: these fine hairs are dust-preventers, and serve to allow only clean air to enter the spiracle (see Figure 270). The last pair of spiracles, situated near the tail-end of the abdomen, are unusually large, and can be opened or closed by the insect at will.

The Water-beetle in want of air rises to the surface of the pool and sticks out its abdomen, and at the same time opens its wing-cases, or elytra, very slightly. Air is taken in by the abdominal spiracles or last pair, and also a supply is gathered under the wing-cases, which is held by the hairs on the back of the abdomen, and forms a large air-bubble.

The insect then plunges down from the surface, and the air under the wing-cases is passed forward to the front spiracles, and thus the beetle, in a state of enforced submergence, can remain under water a considerable period.

The wing-covers, or elytra, are very hard in substance, but very smooth surfaces are found in the male, whereas the female has furrowed wing-cases (see Figure 271). Under these wing-cases are laid the crumpled large wings, only used in flight through the air when the insect travels to a new pond, this being done in the twilight or during early morning.

The legs of the Water-beetle present several modifications and in the male (the fore-legs) this is very marked. The terminal parts form a large developed organ, having on its surface circular suckers and at the tip two small claws (see Figure 272).

Peculiarly, we can find these suckers are also present in the middle legs, but they are not circular, as in the case of those present in the fore-legs (see Figure 273). These circular discs (see Figure 272) have on the under-surface a number of minute stick-shaped projections, and the whole of the modification is fringed with hairs. The two large suckers, placed one on each side, are unequal in size, and specially carried on projecting stalks; each sucker is elastic, and consists of radiating ribs, which close up like an umbrella.

Under the large suckers are many smaller ones, and it has been calculated that in the male there are one hundred and seventy sucking hairs in each fore-leg, and one thousand five hundred and ninety in each middle leg. These suckers are very powerful, and a Water-beetle is difficult to remove if it is attached to a stone or stems of water-plants. The suckers are used chiefly in holding the female during mating periods, and sometimes for holding prey, such as tadpoles and young fish.

The hind-legs are very strong (see Figure 274), and are used solely for swimming purposes, as can be judged by the outline, which resembles an oar in shape. On each segment are present many hairs, which serve to gather water, and so propel the insect forward through the water.

W. HAROLD S. CHEAVIN, F.R.M.S.

INTELLIGENCE IN PARASITIC ROTIFERS. (*Continued from page* 191.)—(2) The second parasitic Rotifer which claims our attention is a fairly large species which has made a speciality of raiding, and living at the expense of, water-snails' eggs, considering, no doubt, that these have been specially provided by Nature for its own special benefit. *Proales gigantea* was first discovered in Ireland in 1892 by Miss Glascott, but was not

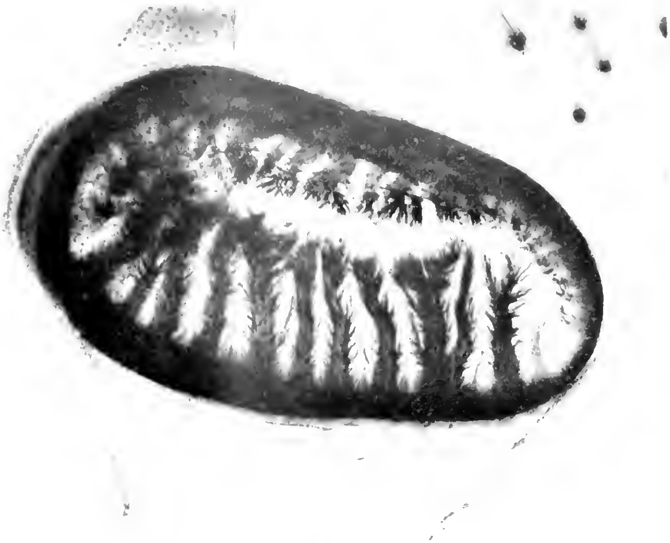


FIGURE 270. One of the posterior spiracles of the Water-beetle. × [illegible]. The spiracles are the openings into the breathing tubes, or tracheae.

FIGURE 271. One of the elytra, or wing-cases, of a Water-beetle (*Colymbites fuscus*). × 36.

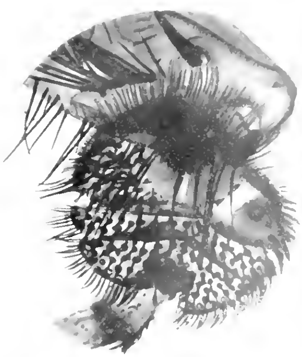


FIGURE 272. Fore leg of male Water-beetle with suckers. × 36.

FIGURE 273. Middle leg of male Water-beetle. × [illegible].

FIGURE 274. Hind or oar leg of male Water-beetle. × 6.

From a photograph *by Charles Reid.*

FIGURE 275. Wild Cats.

(From "Odd Hours with Nature," by Alexander Urquhart. By the courtesy of Mr. T. Fisher Unwin.) See page 276.

From a photograph *by R. Lunn.*

FIGURE 276. The Valley of the Thousand Hills, 5¼ miles S.W. of Kinlochewe, Ross-shire.

(From "The Quaternary Ice Age," by W. B. Wright. By the courtesy of Macmillan & Co.) See page 275.

seen again until the late Mr. John Stevens found it near Exeter in the summer of 1911, causing havoc amongst the eggs of his water-snails (*Limnea auricularia*). It is therefore either very rare or, which is more probable, has not been looked for in the particular habitat where it makes its home: it has never been found swimming about freely in the water, nor has it been reported from any other country. (An account by John Stevens of the life-history of this Rotifer will be found in the *Journal of the Quekett Microscopical Club*, Volume IX, 1912, pages 481-6.)

This Rotifer displays considerable intelligence in the ways and means it adopts to find and then penetrate to its victims. The water-snail's eggs are laid on submerged leaves of water-plants in clusters of one to two dozen, surrounded by a stiff and dense gelatinous substance, which effectively protects them from the predaceous aquatic larvae; but this Rotifer, on coming into contact with such cluster, appears to know that there is something desirable inside the insipid gelatine, and promptly sets to work to penetrate it by a process of pushing, twisting, rolling, and ever inverting and extending its extremities. When, after a good deal of work, an egg is reached inside the cluster, *Proales* finds that the egg-shell is very tough and resistant, and it takes two hours to nibble a very small hole and then push and wriggle itself through the opening in the same manner as has been previously described in the case of *Proales parasita* living in the spheres of *Volvox globator*.

Once inside the snail's egg the Rotifer feeds on the albuminous contents, then begins to nibble at the embryo snail, which, unconscious of the dangerous intruder, continues its slow and regular movements, ever revolving in the fluid contents of the egg. The Rotifer then lays an egg and continues this performance until twelve to fourteen have been laid in the course of three days, and these develop and begin to hatch on the fourth day. The parent then abandons its home for fresh fields, leaving its progeny to look after themselves, of which they are quite capable. The embryo snail, finding its food material disappearing, gets weaker and weaker, and finally dies and dissolves, being absorbed by the family of *Proales* within three to seven days. The young Rotifers leave the snail's egg in which they were born one by one through the opening made by their parent, and make their way through the gelatinous covering to other eggs of the same cluster, and begin the same process, so that very few of the young snails escape and succeed in coming to maturity.

The size of *Proales gigantea* is one fiftieth of an inch, which is large compared with other members of this genus. It possesses a single small red eye in the form of a lentil-shaped cushion of red pigment on which is seated a crystalline sphere measuring one seven thousand five hundredth of an inch in diameter. This eye is situated, as usual in Rotifers, on the brain, a small hyaline cluster of cells, which does all the thinking and guides this small creature in its search for snails' eggs, also devising the method and means by which it overcomes the considerable difficulties in getting inside them.

C. F. ROUSSELET.

(To be continued.)

THE QUEKETT MICROSCOPICAL CLUB.—At a meeting of the Quekett Microscopical Club, held on May 26th, Mr. A. E. Hilton read "Some Notes on the Cultivation of Plasmodia of *Badhamia utricularis*." In place of the fungus, *Stereum hirsutum*, recommended by Lister as the best food for this plasmodium, but which is not always easy to obtain, the author had found that a solution of ammonium phosphate (14 grammes), cane sugar (14 grammes) in water (1000 cubic centimetres) was a quite satisfactory substitute. Bread moistened with water and, occasionally, with the phosphate solution is also good. A method of observing the streaming movements is to allow a plasmodium to become dry on a piece of blotting-paper. A slip of this is taken and placed, as a ring, inside a test tube of suitable diameter. When moistened with water the plasmodium soon becomes active, and is conveniently examined through the walls of the tube. Mr. E. M. Nelson, F.R.M.S., contributed a paper on "Binocular Microscopes." The points gained by binocular vision are: (1) Stereoscopism, or the power of appreciating solidity; (2) Increase of apparent magnifying power; (3) Increase of illumination; (4) Increase of colour perception. The paper deals principally with the four forms of binocular recently introduced: The Greenough, by Zeiss, in 1897; the Ives, in 1902; and the Leitz and the Beck, within the last few months. In the Greenough all the four attributes of binocular vision are secured. The single objective binoculars may be divided into two kinds—those of the Wenham or Stephenson type, which split the beam at the back of the objective, and those of the Powell type, which pass the whole beam. This second class, however, does not possess true stereoscopism. Their use is confined to the employment of full Ramsden discs in each eye, and when prolonged work is undertaken with one of the new binoculars great relief and comfort to the eyes will be secured.

Both Messrs. Beck and Leitz exhibited stands illustrating points touched in Mr. Nelson's paper.

PHOTOGRAPHY.

By EDGAR SENIOR.

A NEW PHOTOGRAPHIC PRINTING PAPER—"SATISTA."—We have lately had an opportunity of trying the paper bearing this name, which has been issued by the Platinotype Company, of 22, Bloomsbury Square, W.C. The sensitive coating on the paper consists of a mixture of platinum and silver salts, but the final results that were obtained from the same negatives on the older platinum paper and this new variety so closely resembled each other that it was difficult to discover any difference between them. We may therefore say that the prints are identical in appearance with those in which the image consists of platinum only. Of course, as the image is partly composed of silver, doubts might be raised as to its equal permanency with those in platinum, but we are told that if the silver is removed by chemical means the platinum will still remain in sufficient quantity to form the picture, so that in that sense the image may be considered as permanent. But still, suppose this is not the case, even then the new paper will be a very valuable addition to the existing printing papers, because it will enable the photographer to produce prints having all the appearance and beauty of a platinum print at a much less cost, the price of a dozen pieces half-plate size costing only 1s. 3d., while at the same time the prints may be considered practically permanent. The printing and general appearance of the image during this operation are to all intents and purposes the same as in platinum printing generally, but the after-manipulations are somewhat different. Thus, the development is effected by immersing the exposed print face up for half a minute in the following solution :—

DEVELOPER FOR BLACK TONES.

Potassium Oxalate	8 ounces
Oxalic Acid	100 grains
Water (Distilled)	40 ounces

This solution will keep indefinitely, and should be used at a temperature of 60° F. After development, the prints are cleared by means of two baths composed of the acid oxalate of potash (salts of sorrel), allowing them to remain for ten minutes in each.

FORMULA FOR CLEARING SOLUTION.

Potassium Hydrogen Oxalate (Salts of Sorrel)	1½ ounces
Water (Distilled)	80 ounces

The prints, on removal from the second clearing bath, must be washed for ten minutes in running water, and this time should not be exceeded, otherwise a yellowing of the prints may result. The unaltered silver salts which the

prints still contain must then be removed by means of hypo, using a solution of the following strength :—

Fixing Bath.

Hypo	2 ounces
Water	20 ,,

The prints are to be allowed to remain in this bath for fifteen minutes, after which they must be washed for forty minutes in running water or repeated changes. If warm black tones are required, these may be obtained by the addition of a little mercuric chloride to the developer, and developing at a temperature of 140° F., while various shades of brown to red will result from toning the prints with uranium, a formula for which is given in the instructions issued with the paper.

PHOTOGRAPHING EMBRYOS.—In photographing these and other small specimens it is convenient to use a vertical camera with the lens attached to the front board of the camera in the usual manner : this is readily accomplished by means of adapters to take the microplanars, or other objectives which it is desired to use. The degree of magnification employed is usually from one up to ten times; and, as in the cases already mentioned, the position of the ground glass for any given magnification is determined once and for all by the use of a scale in millimetres.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A., LL.D.

SO-CALLED SENESCENCE OF INFUSORIANS.—It has been observed that stocks of Infusorians all descended from one individual by successive generations of asexual multiplication are apt to " give out." Senile, degenerate forms occur. This was attributed by Maupas and others to the absence of conjugation. It has been shown, however, that Infusorians are very sensitive to their old waste-products, and to certain peculiarities in the culture-medium. It has been found possible to stave off the senescence by giving tonics of beef-tea and the like. One of the most recent investigations, by Mr. George Alfred Baitsell, reports that conditions have been found in which *Pleurotricha lanceolata* will apparently thrive and multiply indefinitely without conjugation or artificial stimulation. An optimum environment has been discovered.

DECAPITATED YOUNG NECTURUS.—In the early summer of 1898 Professor A. C. Eycleshymer accidentally subjected a large number of Necturus larvae (ten to fifteen millimetres long) to violent agitation. Some of them, which had their heads broken off by the shaking, showed no disintegration, and lived for several weeks. Subsequent experiments on these hardy young Amphibians showed that the decapitated larvae grow slowly, but with apparent normality ; move less than usual, but normally enough ; are pigmented much as usual ; heal their wounds as usual, but at a slower rate ; and regrow their lost gills. A remarkable fact is that the reäctions to light are essentially the same, which shows that there must be a dermatoptic sense able to compensate for the absence of eyes. The case of this Amphibian is a fine illustration of the plasticity or elasticity of some forms of life.

REVIEWS.

ASTRONOMY.

The Call of the Stars.—By J. R. Kippax, M.D. 432 pages. 54 illustrations. 9-in. × 6-in.

(G. P. Putnam's Sons. Price 10/6.)

Yet another book for the amateur astronomer and general reader who has predilections for this subject. It is a substantial volume, and we find that it contains practically everything that such readers can require, without diving into the domains of the more technical and professional astronomer. The author does not claim the introduction of any novelties—it is hard to see how any author could do so, as so many astronomical books have been published in recent years. But, although he has largely drawn upon other authors' works, as is unavoidable—for this he gives very generous acknowledgment—there are repeated cases of the author's own expressions.

" The design of this volume is to present, in plain, non-technical language a concise and accurate story of the starry heavens, together with the legendary lore that time and fancy have associated with them. . . . The book is not intended for the professional reader, who is doubtless already familiar with the facts here given, but for the lay reader, who has but limited time to devote to the subject." We think the author has succeeded in attaining his object, and we believe that the book has only to be seen and it will recommend itself. The book should certainly be included in the library of all keen readers of " Astronomy," of which one page is worth a whole " novel."

The arrangement of the book consists of two parts, one the Stars and the other the Sun and the Planets. The first part is divided into eight chapters. After the first, on General Remarks, follow five chapters on the Night Sky of Spring, Summer, Autumn, and Winter ; then one on the Milky Way, Nebulae, Variable Stars, etc. ; and the last on Stellar Distances, Spectrum Analysis, and Celestial Photography. Part II contains two chapters on the various theories or systems, then eight chapters relating to the Sun, the Moon, and major Planets, and the last treats of Comets and Meteors. Following this is a good index, though we notice some omissions, which gives the useful pronunciation of the constellations and Arabic names.

In the pages 32 to 216, which are mainly descriptive of the constellations, their configurations, and individual stars, the author gives numerous and appropriate poetic allusions—as in other parts of the book. The information throughout is quite up to date, and the selection of the illustrations—mainly whole plates—has been drawn from the best sources. We notice the omission of some important books in the list of authorities consulted ; other omissions and inaccuracies in the whole book are very slight and small in number.

The paper and printing are excellent, as might be expected from the " Knickerbocker Press " ; the price is quite moderate.

F. A. B.

CHEMISTRY.

Physical Chemistry. Its Bearing on Biology and Medicine.—By J. C. Philip, M.A., D.Sc. Second Edition. 326 pages. 24 illustrations. $7\frac{1}{2}$-in. × $7\frac{1}{4}$-in.

(Edward Arnold. Price 7/6 net.)

The methods of physical chemistry are being applied to an increasing extent to the solution of problems of biology and physiology, and the aim of this book has been to give an outline of this branch of the science, with especial reference to this particular purpose. The appearance of a new edition within a year or two of the first publication is a matter for congratulation to the author, and a proof that the book has satisfied a demand. The present edition follows the lines of its predecessor, and discusses with sufficient detail for theoretical purposes such subjects as Osmotic Pressure, Colloidal Solution, Adsorption, and the Velocity of Chemical Reäctions, including the physics of enzymic action. The new matter includes a brief outline of Czapek's researches upon the Permeability of the Cells of Higher Plants and a chapter on Electro-motive Force,

References are given to the original publications quoted, and there is an excellent subject index and index of authors. The book is a welcome addition to the library of all whose work is concerned with the chemistry of the life processes of animals or plants.

C. A. M.

ENGINEERING.

The Calculus for Engineering Students.—By JOHN GRAHAM, B.A., B.E. 355 pages. 7½-in. × 5-in.

(E. & F. N. Spon. Price 5/- net.)

The demand for this concise little textbook has necessitated a fourth edition, which indicates that it supplies a much-felt want. The general arrangement is good, and enables the student to progress on sound lines.

In the introductory chapters the author summarises certain algebraic and trigonometrical theorems, a clear knowledge of which is essential if any advance is to be made in the study of the Calculus.

A good feature in the body of the book is the insertion of the solution immediately after each problem, which effects a saving of time to the reader, and enables many problems to be utilised as a reference list for Differential or Integral results.

The first eleven chapters are devoted to progressive instruction in the Differential Calculus, followed by eleven on the Integral Calculus and its applications, the concluding eight chapters being chiefly devoted to the solution of Differential Equations. The author is to be congratulated on the use made of graphical demonstrations of the elementary theorems of the Calculus, which should enable the beginner to readily grasp the principles involved. For the sake of clearness, however, fundamental theorems might be printed in heavier type.

The textbook includes the mathematical investigation of many standard formulae connected with Mechanics, Electrical and Mechanical Engineering. A slight lack of precision in definition is noticeable here and there; as, for example, in the opening definition of a periodic function on page 184. The value of the set of miscellaneous examples at the end would be enhanced if the solutions were indicated. After all, a textbook is better not to be a hunting-ground for home work or examination problems. A few minor errata and omissions were noted on a first reading, but these will no doubt be remedied in the next edition.

Apart from the minor points touched on, the author is to be congratulated on a most useful addition to the library of the engineering student who desires a working knowledge of Elementary Calculus.

J. K. R.

GEOLOGY.

The Quaternary Ice Age.—By W. B. WRIGHT. 464 pages. 155 figures. 23 plates. 9¼-in. × 5¾-in.

(Macmillan & Co. Price 17/- net.)

There is no general work in English, says Mr. Wright, which might serve as a guide to the literature of glacial geology, or enable the geologist to grasp the leading features of the subject. The present volume not only fills this want, but contains a great deal of reasoning and speculation, for which the author himself is responsible. The glaciation of Europe generally, of the Alps, and of North America, is discussed in detail. In the present state of our knowledge a correlation of the various stages in the different countries can only be surmised. Mr. Wright looks to archaeology in the near future to make clear the relation between the North European and Alpine glaciation, but he is not so hopeful in the case of Europe and North America. As illustrating the slowness with which a fundamental idea creeps into geological science, we may mention the theory of the production of the deposit known as loess by the wind.

Not the least interesting chapters are those which deal with quaternary mammals and with man. The latter includes a most useful summary of the various stages in palaeolithic culture, and a discussion of the transition period which leads to the neolithic, as well as a consideration of the latter itself. The theories of the Ice age are outlined, and, as the researches which have been made in Scandinavia into post-glacial geology are world-famous, the oscillations of level in that part of Europe are described with considerable care. Mr. Wright develops to a considerable extent the isostatic theory put forward by Jamieson, to whom the volume under consideration is dedicated. The theory implies that there is a certain amount of hydrostatic balance between the different elements of the Earth's crust, so that if an additional load be imposed on any portion of the surface, it must necessarily sink, and the remainder of the surface rise until equilibrium is reëstablished. Examples of such loads are to be found in the accumulations of sediment round the mouths of great rivers. The isostatic depression of ice-sheets is that, however, which occupies Mr. Wright's attention, and he claims that it has attached to it a very high degree of probability. In fact, one of the important points in his book is his endeavour to show that the complicated Earth movements which have in the past been commonly evoked to explain the late glacial and post-glacial changes of level in Scandinavia are not at all necessary, and that all the observed phenomena may be accounted for in the simplest manner by unchecked isostatic recovery from the effects of the ice-load, combined with a single oscillation of the sea level.

A pertinent quotation from Gilbert says: "When the work of the geologist is finished, and his final comprehensive report written, the longest and most important chapter will be upon the latest and shortest of the geological period." Those who read carefully what Mr. Wright has to say will agree most thoroughly with his concluding words, that we have in the history of the quaternary period a region of research full of hope and of the most romantic interest, promising not only to reveal the events which have accompanied and influenced the evolution of man, but to afford an outpost from which we can look back into the ages which preceded his advent upon the Earth.

We are kindly permitted to reproduce one of the plates in Figure 276 (see page 272), and we may further say that the illustrations are most helpful, and add to the value of the book, which should be on the shelves of every naturalist and archaeologist.

W. M. W.

METEOROLOGY.

Climate and Weather of Australia.—By H. A. HUNT, GRIFFITH TAYLOR, and E. T. QUAYLE. 93 pages. 39 plates. 9¼-in. × 6-in.

(Melbourne: A. J. Mullett. Price 5/-.)

This is one of the publications issued by the Commonwealth Bureau of Meteorology, and is a concise and valuable textbook on Australian Meteorology.

In area Australia is about three-quarters that of Europe, and contains (with Tasmania) 2,974,581 square miles. It is characterised by a very uniform outline, and by a lower average elevation than any other continent. Since Australia extends over so many degrees of latitude, its northern area comes under the inflence of equatorial conditions, where the four seasons are not so well marked as, for instance, in Europe. Here the major divisions are the wet and dry seasons. But there is a difference of ten degrees between the mean temperatures of January and July, and there is a remarkable dissimilarity between the muggy conditions in January—when the heaviest rain for the year falls—and the dry heat of July. In the southern area the division of the year into four seasons is well marked, though over the greater portion of the year definite wet and dry periods are still noticeable.

The highest temperatures are recorded over the north-western portion of Western Australia, where the maximum shade temperatures have exceeded one hundred degrees on sixty-four consecutive days and ninety degrees on one hundred and fifty consecutive days, the mean temperature

of the hottest month being ninety degrees and that of the coldest month sixty-five degrees.

The coldest portion of Australia is the Australian Alps, situated in North-eastern Victoria and South-eastern New South Wales, where the mean shade temperatures range from sixty-five degrees in January to forty degrees in July. During exceptionally dry summers the temperatures in the interiors reach, and occasionally exceed, one hundred and twenty degrees, and the same areas during the winter months are subject to ground frosts.

Australian weather is controlled by three belts of atmospheric eddies. In the north, moving generally from west to east, along the Tropic of Capricorn, is a procession of low-pressure systems which are usually termed "monsoonal lows." South of latitude forty degrees is another series of cyclonic eddies—probably secondaries strung along the great low-pressure belt of the Southern Ocean. These are called "antarctic cyclones." Between the two lies the belt of anticyclones whose path swings between latitude thirty degrees and forty-two degrees as the Sun moves south and back again.

The whole coast of Australia, from Perth northward and east to Brisbane, is at times influenced by the South-east Trade Winds. The rains of Australia fall mainly in connection with the tropical depressions and the southern or antarctic depressions. The former rain-bearing factor operates over two-thirds of the continent, roughly, over that portion of Australia lying to the north of a line extending approximately from Cossack, on the north-west coast, to Sydney, on the south-east coast, the rainy season being from December to March inclusive, and the wettest month January. The remaining third of Australia's area receives its rains principally through the southern depressions which operate during the autumn, winter, and spring months, with the heaviest monthly totals in June.

Space will not permit any further details to be given, but the authors deal with many other climatic features, and also with the characteristics of drought years and of local rains, as well as special types of weather. The book is copiously illustrated with maps and charts, showing mean monthly and annual temperature, pressure, and rainfall, as well as types of weather and special phenomena.

W. M.

NATURAL HISTORY.

Odd Hours with Nature.—By ALEXANDER URQUHART. 323 pages. 32 illustrations. $8\frac{1}{4}$-in. × $5\frac{1}{4}$-in.

(T. Fisher Unwin. Price 5/-.)

There are many articles written nowadays for the general press which contain interesting observations on natural history, and it would be a pity if, after they have served their immediate purpose, all of them were lost. Hence we welcome the series of essays, written for *The Dundee Advertiser*, which Mr. Urquhart has collected under the title of "Odd Hours with Nature." We may take at random one or two of the subjects discussed. In one article the house-sparrow and the tree-sparrow are compared as regards their appearance and their psychology. The robber bees who pierce the spurs of the Delphiniums form the subject of another essay; that wild cats are not so scarce as might be imagined is brought out in the third; while such subjects as wasp-plagues, the winter play of birds, and the assuming of male plumage by hen birds, go to make up an interesting whole. Figure 275 (see page 272), from a photograph by Mr. Charles Reid, of two wild cats, is reproduced by permission from "Odd Hours with Nature."

W. M. W.

PHYSICS.

A Text-book of Physics.—By J. H. POYNTING and SIR J. J. THOMSON. Volume IV. Electricity and Magnetism. In Three Parts. Parts I and II. Static Electricity and Magnetism. 345 pages. 246 illustrations. 9-in. × $6\frac{1}{2}$-in.

(C. Griffin & Co. Price 10/6.)

The appearance of this new instalment of an important text-book was separated by only a few days from the announcement of Professor Poynting's death, and so a melancholy interest attaches to the volume under consideration. The admirable characteristics of the earlier volumes, on Properties of Matter, Sound, and Heat, are again evident in the new one. The chapters on Static Electricity begin with a clear and well-selected account of common phenomena. This serves as an introduction to the measurement of electrical charge, strain, and potential, the presentation of the notions being marked by an intimate acquaintance with the difficulties of the average student. Needless to say the development of Faraday's treatment of the subject, which we owe to Sir J. J. Thomson, is not missing. In the Magnetism chapters, again, the same method of treatment is followed, a simple account of the elementary facts coming first. The subsequent development of theory is accompanied throughout by a full statement of experimental results, and the chapters on Permeability, and on Magnetism and Light, are remarkable for completeness and clearness of exposition. The Electron theory is only occasionally introduced, its full consideration being deferred to the companion volume, on Current Electricity, which Professor Poynting's preface leads us to expect shortly.

W. D. E.

X-Rays: An Introduction to the Study of Röntgen Rays.—By G. W. C. KAYE, Head of the Radium Department at the National Physical Laboratory. 252 pages. 97 illustrations. $8\frac{3}{4}$-in. × $5\frac{1}{2}$-in.

(Longmans, Green & Co. Price 5/- net.)

This fascinating book on x-rays will receive a warm welcome from all those who have been attracted by the developments of modern physics. The literature of the subject is now so extensive that it is impossible for any but a specialist to collate the material adequately, and the work before us by one who has contributed in no small measure to the subject is unapproached in authority among existing English books. To medical men especially the book will be invaluable.

There are thirteen chapters in the volume, together with an Introduction and five Appendixes, the unusually large number of the latter being attributable doubtless to the rapid growth of the subject while the book was in the press. (We noticed one reference as late as April, 1914.) The early chapters give a clear account of the chief features of a vacuum-tube discharge, and one can readily appreciate the important parts played by both the cathode rays and the positive rays in an x-ray bulb.

Following this is a simple account, for the benefit of the novice, of the method of generating x-rays. The historical and present-day development of the x-ray bulb is fully gone into. There is a good chapter on induction coils, Wimshurst machines, and so on, followed by one dealing comprehensively with the various methods of testing and measuring x-rays both in quality and quantity. One of the best sections in the book is that on monochromatic x-rays, the characteristic x-rays of Barkla. Then comes an account of C. T. R. Wilson's condensation experiments illustrated by several plates.

The present state of x-ray radiography and radiotherapy is well set out in later pages, which display some good examples of modern x-ray technique.

One of the most satisfying chapters is that which expounds the very recent and important work of Bragg, Moseley, Laue, and others on the diffraction of x-rays by the serried rows of atoms in a crystal. This work, which has settled conclusively that x-rays are an extreme form of ultra-violet light, bids fair to establish a new branch of crystallographic physics of surpassing importance. The final chapter deals with the nature of the x-rays; and the Coolidge x-ray bulb is described in an Appendix.

Sir James Mackenzie Davidson contributes a delightful

story of the discovery of the x-rays by Professor Röntgen in 1895, and the book is further enlivened by the presence of a clever parody on the circumstances attending the genesis of an x-ray.

Many workers will find the numerous tables which are scattered throughout the book of great value.

To summarise, Dr. Kaye has accumulated a great deal of valuable information in his book, and has put it out in a very compact and interesting form. The appearance of the book is unusually attractive, and the diagrams and plates, of which there are close on a hundred, deserve a word of praise.

We consider that for some time to come this will be the classic book on x-rays, to which the student may refer with the full conviction that he will find an absolutely scientific and reliable guide.

W. D. B.

ZOÖLOGY.

A Text-book of General Embryology.—By WILLIAM E. KELLICOTT. 376 pages. 167 illustrations.

Outlines of Chordate Development.—By WILLIAM E. KELLICOTT. 471 pages. 185 illustrations.

Both volumes 8-¾in. × 5½-in.

(Constable & Co. Price 10/6 net each volume.)

Embryology and development, which are, in reality, no more than different grades and aspects of one and the same subject, ought to form the most fascinating of all branches of zoölogical studies, showing, as they do, how there is a gradual transition and advance from the simple dual fission of the lowly monad to the complicated and elaborate series of changes undergone by the human embryo before culminating in the birth of a being but one degree lower than the angels. And yet how comparatively small is the number of zoölogists who know anything at all, or, at any rate, anything worth knowing, of this marvellous and fascinating science, most of them being content to go on from year's end to year's end describing so-called new races or species in the belief that such work constitutes the final end and aim of zoölogy. To such we say, although we fear that we say it in vain: Learn to know something of yourself, and of the ties by which you are bound on the one hand to the lowest members of the animal kingdom, while on the other, if we may say it with all respect and deference, you lay claim to kinship with the eternal and omnipotent Godhead.

To those who feel the sting of this reproach, and respond to the stimulus for a desire for better things, and a wider field of thought, we can confidently recommend the two excellent little volumes which form the subject of this notice. For, although designed by an expert teacher for the use of his students, they are so thoroughly well written and so excellently well illustrated that they can be read by anyone with a fair knowledge of anatomy and zoölogy, not only without difficulty, but with actual pleasure and appreciation. It may be added that since the first part of Dr. Przibam's well-known text-book of Embryogeny was published so long ago as 1908, Professor Kellicott, who, by the way, occupies the Chair of Biology at Goucher College, has much to tell us that is not to be found in works hitherto available to the student.

In the first of the two volumes—"A Text-book of General Embryology"—the author, after repeating the old saw, in English, of "*omne vivum ab ovo*," commences with a chapter on Ontogeny, in which are reviewed the processes of reproduction by fission, budding, and ovulation, culminating in the last case by the development of a placental connection between the maternal parent and the embryo formed from the small-yolked ovum, so different in character and function from the big-yolked egg of the Sauropsida and Monotremata. Of surpassing interest are the paragraph and diagram in this chapter descriptive and illustrative of the marvellous and fascinating theory of the continuity of the germ-plasm. The cell and cell-division, germ-cells, and their formation, maturation, fertilisation, and cleavage (of the ovum), form the titles of succeeding chapters, which are followed by others dealing with differentiation, heredity, and sex-determination in the germ-cells, and the nature and development of the blastula, gastrula, and germ-layers.

The second of the two volumes—"Outlines of Chordate Development"—may be regarded as a sequel to the first, dealing as it does with the derivation of the vertebrate phylum from some type of invertebrate stock by means of an organism more or less nearly (or shall we say remotely?) related to the lancelet, and culminating in the developmental history of man himself, from the early embryonic stage to the full-time foetus. If such a comparison be not invidious, it may be said, indeed, that this volume is of even greater interest than its fellow. As usual in works of this nature, a large amount of space is devoted to the development of the lancelet (*Amphioxus*) and the frog, the latter showing the leading features of vertebrate development much better than any other animal. In regard to the lancelet the author observes that, whether or no it represents a really primitive type of development, it affords, in simple style, the essentials of early chordate autogeny, such specialised features as occur in the later stages merely serving to warn the careful student against drawing too precise phylogenetic inferences from embryological facts. The chapters on the Chick are shorter, and, to a certain extent, supplemental to those on the Frog. The final chapter, on Mammalian Development, includes only those phases that are of chief interest to the general student, namely, the earlier stages in the development of the embryo, the establishment of its connection with the maternal organism, the development of the foetal membranes and appendages, and, lastly, that of the external form in the later phases of the human foetus.

While according the highest praise of which we are capable to these two excellent and readable volumes, we must enter a word of protest against the eccentricities in spelling with which they are in places disfigured. The worst of these occurs on page 350 of the "Chordate," where we find "roughing-in" apparently doing duty for "roofing-in," which is neither more nor less than an insult to an English reader.

R. L.

Artificial Parthenogenesis and Fertilisation.—By JACQUES LOEB. 312 pages. 77 illustrations. 8¾-in. × 5¾-in.

(University of Chicago Press. Price 10/- net.)

The present volume is not only a condensed account of Professor Loeb's previous researches, but it contains the author's recent additions, and is quite up to date. Like all Professor Loeb's writings, it is direct and to the point, containing not a superfluous word, with no attempt at fine writing, or indeed a literary polish. But the marvels it deals with require, like good wine, "no bush." When one compares the state of our knowledge as to the processes of fertilisation, and maturation of the ovum when the Brothers Hertwig first published their experimental observations in 1887 with what it is nowadays, largely due to the work of Professor Loeb and his school, it is difficult to believe that but twenty-seven years have elapsed. The book should be in every zoölogist's library, and it will appeal equally to the botanist, the physiologist, and the physiological chemist. Every page is well worth reading, but the busy teacher who is not a cytologist will probably gain most by perusal of the first, second, ninth, twenty-second, and last chapters. The work described is chiefly experimental, and those who wish to learn the views of a master craftsman like Professor Loeb towards such questions as Vitalism and the Mechanism of Living Matter must seek them elsewhere. In the present volume the author has "let a plain statement suffice," but one that is of surpassing interest and importance.

M. D. H.

NOTICES.

THE INSTITUTE OF METALS.—The autumn conference of the Institute of Metals is to be held at Portsmouth on September 10th and 11th, 1914.

THE LIVINGSTONE COLLEGE YEAR BOOK, 1914, contains an account of recent progress in tropical medicine, and reviews of medical and hygienic literature of interest to Livingstone College students, many of whom become missionaries in tropical countries.

NATURAL PHILOSOPHY.—Professor T. R. Lyle, M.A., D.Sc., F.R.S., is resigning the Chair of Natural Philosophy in the University of Melbourne. The emoluments attached to this post amount to about £1000 per annum. Professor Lyle's successor (who has not yet been appointed) will enter upon his duties at the beginning of the next academic year, the end of February, 1915.

THE GOLD MEDAL OF THE AËRONAUTICAL SOCIETY.—The Council of the Aëronautical Society of Great Britain has awarded the Gold Medal of the Society to Professor G. H. Bryan, Sc.D., F.R.S., for the great services he has rendered to Aëronautics by his development of the theory of the Stability of Aëroplanes. Previous recipients are Wilbur and Orville Wright (1909) and Octave Chanute (1910).

DURBAN MUSEUM.—We welcome the appearance of the first number of the Annals of the Durban Museum, which will be issued at intervals when matter for publication is available. The part before us contains papers on the pelagic Entomostraca of Durban Bay and on the South African Porpoise, while the Editor, Mr. E. C. Chubb (Curator of Durban Museum), contributes a descriptive list of the Millar Collection of South African Birds' Eggs.

THE PHOTOGRAPHIC SURVEY AND RECORD OF SURREY.—In the year 1913 nine hundred and twelve prints were added to the collection, which now numbers six thousand eight hundred and five, and one hundred and six lantern slides were received, bringing up the total to one thousand four hundred and thirty-four. The public made eight thousand one hundred and ninety-three references to the Survey Collection during the year 1913.

THE MUSEUMS CONFERENCE AT HULL.—Number 101 of the Hull Museum Publications contains reprints of the Museums Committee minutes, and of the account of the Museums Association Conference at Hull in 1913, together with a paper by the Curator, Mr. T. Sheppard, which describes how the various museums of Hull were secured, and incidentally how the writer makes the most of his opportunities. Curators of local museums should find the paper very stimulating.

SELBORNE LECTURES. — The Extension Lecture scheme of the Selborne Society has become so successful that it has been found possible this year to issue a handbook of fifty pages, giving particulars of the lectures. There are many local societies which cannot afford big fees, and plenty of county people who are glad to arrange lectures in their villages: to these the handbook should prove most useful. Particulars can be obtained from the Extension Lecture Secretary, Mr. Percival J. Ashton, at 37, Walbrook, E.C.

THE EGYPTIAN ZOÖLOGICAL GARDENS.—We have been favoured with a copy of Captain Stanley Flower's Report of the Zoölogical Gardens at Giza, near Cairo, for the year 1912, issued by the Egyptian Ministry of Public Works, from which it appears that this admirably managed institution continues to make the progress for which it has been noted during the last few years. Among numerous illustrations, especial interest attaches to one of a young Blue Nile Elephant, as showing the enormous ears characteristic of that race.

MESSRS. SIMPKIN, MARSHALL & CO. have issued a third edition of the A B C Guide to Astronomy by Mrs. H. Periam Hawkins (price 1/6 net). In this edition Mrs. Hawkins has had the assistance, not only of Dr. Crommelin, but also that of Messrs. W. F. Denning, J. A. Hardcastle, and H. P. Hollis. The Guide forms a most estimable book for quick reference for all amateur astronomers. The Revolving Star Map (1/-) has been greatly improved this year by the addition of a movable declination scale, while the Star Almanack retains its high standard of excellence.

THE BRITISH ASSOCIATION.—Those members of the British Association who do not journey to Australia this summer will be welcomed by the French Association for the Advancement of Science at its Havre meeting from July 27th to August 2nd. All that is necessary is for the visitor to possess a British Association ticket. New members may be enrolled on the introduction of an old member, and relatives of members accompanying them or persons recommended by members of the Association will be enrolled as Associates for the purpose of attending the meeting at Havre. The Associate's subscription is one pound. Copies of the provisional programme, and any further details, can be obtained from the Assistant Secretary of the British Association, Burlington House, London, W., and application must be made not later than July 18th. Dr. A. Loir, Comité Local de l'Association Française, Bureau d'Hygiène, Hôtel de Ville, Le Hâvre, has kindly undertaken to deal with any communications addressed to him from members with regard to hotel accommodation, which may be obtained at from twelve to twenty francs per diem. The Conference of Delegates of Corresponding Societies of the British Association will meet officially at Havre on Tuesday, July 28th. The Chairman is Sir H. G. Fordham, the Vice-Chairman, Sir E. Brabrook, and the Secretary, Mr. Wilfred Mark Webb.

THE COMMITTEE FOR THE ECONOMIC PRESERVATION OF BIRDS.—As the views of the Committee for the Economic Preservation of Birds have been either misunderstood or misrepresented, the majority of the members has signed a letter in which the following six suggestions are put forward as a working basis: (1) Absolute protection during breeding season for all breeding wild birds of whatever kind. (2) Absolute protection for all birds found upon enquiry to be either verging upon extinction, highly localised, or of determined benefit in agricultural centres. These birds to be known as "Birds of Class I." (3) Regulations to be enforced by Government or local authorities under Government for species that have commercial value and are not in danger. These birds to be known as "Birds of Class II." The Government of the countries of origin to tax the sale of these species, and thereby recover the cost of enforcing regulations. (4) The permanent maintenance of an International Committee of Scientific experts to determine year by year which species belong of right to the respective classes. (5) An International Agreement to refuse importation to the world's markets, museums, and private collections of all species that are found to belong to "Class I." (6) All species in "Class II" to be exported under licence. A list of the birds is also given which would at once come into Class I, and the following are the signatories: Dr. P. Chalmers Mitchell, F.R.S. (Chairman); F. G. Aflalo; Dr. Dudley W. Buxton; C. F. Downham; F. Martin Duncan; G. K. Dunstall; Douglas English; Professor J. Stanley Gardiner, F.R.S.; Professor Marcus Hartog; W. D. Henderson; M. Davenport Hill; H. Knight Horsfield; Louis Joseph; Professor H. Maxwell Lefroy; Sir Edmund Giles Loder; Professor E. W. Macbride, F.R.S.; Professor A. Meek; Professor E. A. Minchin, F.R.S.; C. E. Musgrave; Professor Robert Newstead, F.R.S.; Hubert H. Poole; Robert H. Read; Hugh Scott; Professor C. G. Seligmann; A. E. Shipley, F.R.S.; The Rev. Thomas R. R. Stebbing, F.R.S.; Professor D'Arcy W. Thompson, C.B.; Professor J. Arthur Thomson; Hugh Boyd Watt; W. Percival Westell; A. Wingfield; S. L. Bensusan and Wilfred Mark Webb, Secretaries.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

AUGUST, 1914.

WIRELESS TELEGRAPHY IN AËRONAUTICS.

By BERNARD LEGGETT.

THE advances made within recent years in aërial navigation have led to the necessity for a means of communication between airships and aëroplanes, as well as between them and the Earth.

Although aërial vessels are used to some extent as a new form of sport, their use up to the present for the transport of passengers or cargo has been limited. Their chief use at the present day is for military purposes, such as scouting and the control of artillery fire. An aërial vessel used for these purposes, without an efficient method of communication with its base, is at a considerable disadvantage, since, to impart information obtained during its flight, it must return to its base, which entails loss of time, so that not only is it impossible for its communications to be immediately used, but also the period of its usefulness is curtailed by the time necessary for its flight to and from the base.

Communication might be achieved by semaphores; but this method of signalling is not an ideal one, is comparatively slow, and is possibly useless in the case of aëroplanes flying at high speeds.

The ideal method would be to impart the intelligence by electrical means, and this is only possible by the use of wireless telegraphy.

The installation of wireless apparatus upon aërial vessels greatly facilitates the navigation of the vessel when surrounded by clouds, and permits the aëronauts to receive intelligence regarding their position, the approach of storms, winds, and fogs.

The first attempt to employ wireless telegraphy for aërial purposes was made so long ago as 1898 by Professor Slaby in conjunction with the Prussian Airship Corps. The attempt was carried out with balloons, and it was then found possible to equip these with receiving apparatus only, owing to the small carrying capacity of these vessels and to the fact that wireless apparatus had not then been brought to the perfection obtained nowadays.

Wireless apparatus was also to be employed in the ill-fated Wellman Airship Expedition to the North Pole.

At the present time the majority of the Zeppelin airships is fitted with wireless apparatus, and around the frontier of Germany a series of land stations has been erected (see Figure 287), so that by means of the intensities of the signals received from several stations the position of the vessel may be fixed. These stations are erected upon tall smoke-stacks, and are worked automatically, signals being sent without the constant attendance of an operator. Larger stations are also erected to impart information regarding the weather.

The three most important considerations in the equipment of aërial craft of any form with wireless telegraphy apparatus are the following :—

(1) The question of weight, which necessitates the generating plant and telegraphic apparatus being of exceedingly light construction.

(2) The danger of sparking, causing explosions in vessels of the balloon type.

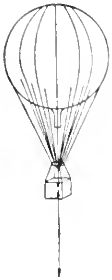


FIGURE 277.
Balloon Aërial
(Meyerburg).

(3) The entire absence of any method of "earthing" the apparatus. This entails the construction of an artificial earth or counterpoise, consisting of an arrangement of wires with a large electrical capacity extending over an area as large as possible. Such a counterpoise is used for all portable stations, and is also often used for land stations when a good earth-connection in the ground water cannot be obtained.

Since the last requirement necessitates features entirely absent in land stations, we shall consider it in detail.

AËRIALS AND COUNTERPOISES.

The natural position for the aërial of a flying vessel is for it to hang below the passenger cage. As the aërial, if permanent, would be an impediment to the navigation of the vessel when flying low, tending to become entangled in trees, and so on, it must be capable of being quickly lowered or wound up. Further, to guard against the possibilities of its becoming entangled, with dangerous results, it must be made capable of only being able to withstand a moderate tension, so that it may become automatically detached if necessary.

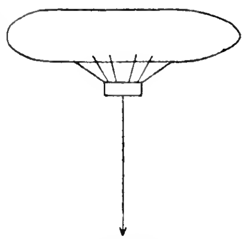


FIGURE 278.
Balloon Aërial.

The aërial wire is usually made of phosphor bronze, and is wound upon a winch. At its lower end it carries a plumb bob to keep it taut when unwound, and to cause it to unwind quickly when required. In the case of airship stations, this winch is above the telegraphic apparatus, and is fitted with mechanism to indicate the length unwound. It is also coloured in different lengths, corresponding to the lengths suitable for the fixed wave-lengths for which the transmitting apparatus is designed. In the case of aëroplanes, the winch is near the telegraphist. Such a winch is shown in Figure 281, where the leaden plumb bob may be seen, and also a brake to operate the winch. The aërial is conducted away from the neighbourhood of the propeller and other revolving parts of the vessel by a copper tube to ensure that it does not become entangled with these, which would naturally cause fatal results. The wire is also jointed at distances of five metres, so that if entangled with the Earth it may break off when the tension amounts to from five to ten kilogrammes. Often a special device is fitted which automatically cuts the wire when the tension exceeds the normal tension. The aërial is in electrical contact with the winch.

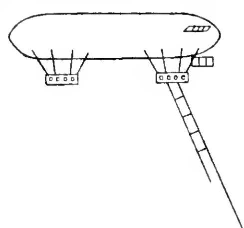


FIGURE 279.
Airship Aërial (Beggerow).

The counterpoise, in the case of balloons, is composed of the metal parts of the passenger car (see Figure 278). Where the capacity of this is not sufficient, a conducting net passing completely round the gas bag is provided, as in Figure 277. This form of counterpoise is due to Meyerburg (D.R.P., No. 232257), and has the advantage that it not only gives a very large counterpoise, allowing a very long aërial to be used and long ranges to be obtained with comparatively small generating plant, but that it effectually protects the gas bag from the sparks caused by natural electrical discharges, which often lead to fatal accidents.

Dr. Beggerow has also patented (D.R.P., No. 225204) a form of aërial shown in Figure 279. Here the counterpoise is obtained by hanging two wires, one of which is much longer than the other, both being in metallic connection so far as length permits. The jointed portions form the counterpoise while the extra length of the longer wire forms the aërial.

This method gives a very efficient aërial, and also ensures all high-tension wires being removed from the neighbourhood of the gas bag.

The form of aërial adopted upon the Zeppelin airships is as shown in Figure 280, and is due to Professors Braun and von Sigsfeld. It is highly directive in the vertical plane through the length of the gas bag.

The counterpoise is formed by the two vertical wires and the aërial by the horizontal wires in the case when the former wires have each a length of $\frac{1}{4}\lambda$ and the latter a total length of $\frac{1}{2}\lambda$. Various wave-lengths are obtained by the insertion of self-inductance coils in the horizontal wires, and by lowering or raising the vertical wires to the requisite extent.

In the case of aëroplanes, the counterpoise is obtained by means of the propelling motor, cooler and other metallic parts, and by use of the stays, these being increased if necessary.

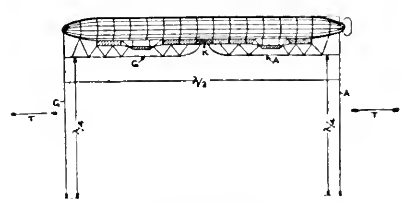


FIGURE 280.
Directive wireless aërial of a Zeppelin Airship.

FIGURE 281.

Aéroplane wirel[illegible] W[illegible]
shown [illegible]

FIGURE 282.

Aeronaut's [illegible] helmet with [illegible] telephone
for the [illegible] of wirele[illegible] signals.

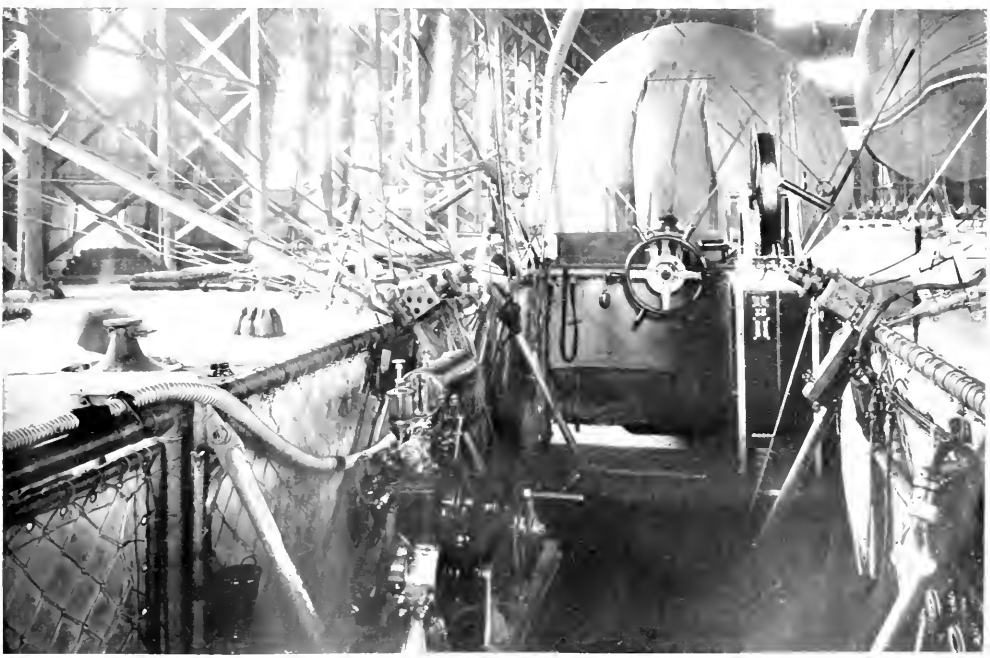


FIGURE 283.

Arr[illegible] in [illegible] of the [illegible]

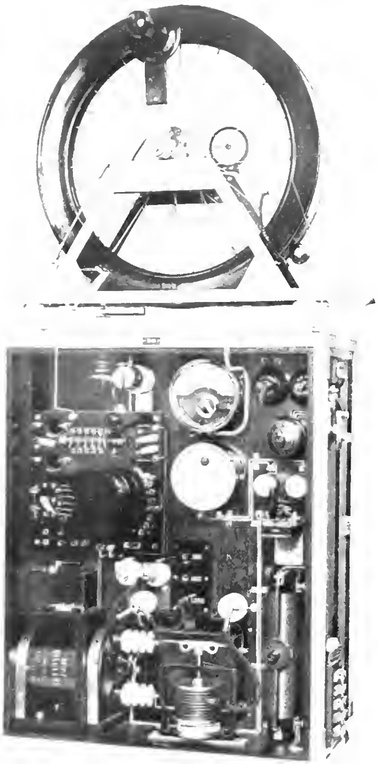


Figure 284.

Airship Station, showing spark gap, transformer, Morse key, aërial ammeter, and receiver, with aerial winch above.

Spark Gap.

Figure 285.

Large Aëroplane Transmitter and Receiver.

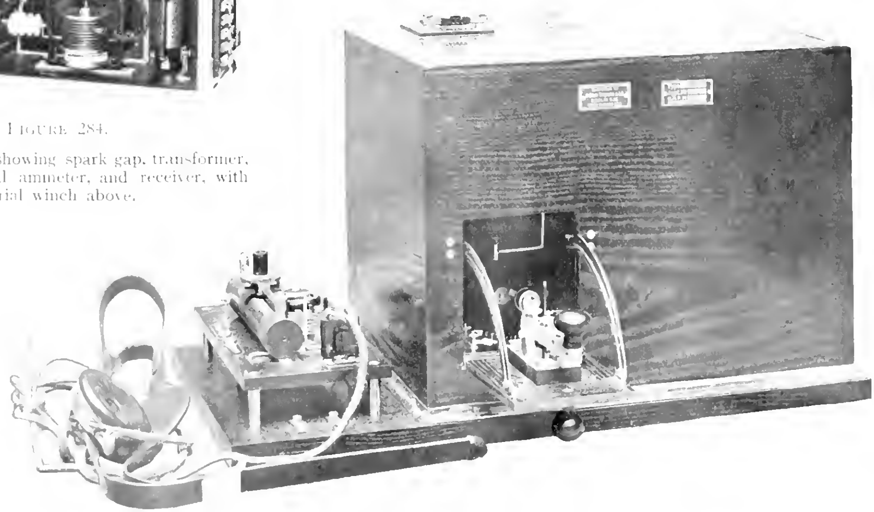


Figure 286.

Small Aeroplane Wireless Station.

AËROPLANE STATIONS.

Two stations for aëroplanes are made by the Gesellschaft für drahtlose Telegraphie, or "Telefunken" Company.

The smaller station is for the smallest type of aëroplanes, or for balloons, which direct the fire of an artillery battery, for which purpose a range of about twenty-five kilometres is ample.

This station is illustrated in Figure 286. The wooden case contains the complete transmitting apparatus with the exception of a battery of cells or accumulators which supply the necessary power. The current is transformed to the necessary high tension by means of a hammer-break induction coil inside the case. The only connections required for transmitting are those between the aërial and transmitter and transmitter and counterpoise, these connections being made by means of the terminals seen at the top of the wooden case.

In the front wall of the case is seen a small trap upon which the Morse key is fixed. Regulation of the coupling between the aërial and the primary circuit, as well as variation of the self-induction of the aërial lengthening coil, is obtained by means of two hand wheels outside the case. If required, these hand-wheels can be adjusted simultaneously. Near the aërial and counterpoise terminals can be seen a helium tube, which indicates resonance between the primary and secondary circuits.

Upon the base-plate of the transmitter is arranged the receiver. This is also connected to the aërial and counterpoise by means of plug-sockets. Upon this receiver-plate is a sliding coil for tuning the aërial. A detector and telephone are in parallel with this coil, the telephone being shunted across a blocking condenser. The telephone is built into a padded helmet, illustrated in Figure 282, in order to deaden the noise due to the aëroplane motor. The total weight of the station is about twenty-five kilogrammes.

The larger station is not dependent upon batteries, but is worked by an alternator driven by the aëroplane motor. This station radiates 1 kilowatt of electrical energy. Its total weight, including the aërial, is from forty to fifty kilogrammes, and its range is about 100 kilometres. The installation is intended for aërial scouting purposes.

The small five-hundred-period alternator, working at three thousand revolutions per minute, is geared to the propeller shaft of the aëroplane, this working at from one thousand one hundred to one thousand two hundred revolutions per minute. A clutch is provided, so that the motor can be quickly started or stopped from the telegraphist's seat. This alternator generates about ·2 kilowatt at one hundred and ten volts. It is excited by means of a small direct-current generator directly built upon the rotor. Regulation of the exciting current is obtained by means of a sliding resistance.

The one hundred and ten alternating current is transformed to eight hundred volts by a transformer, and charges a single mica condenser, the capacity of which is appropriate to the aërial used. The spark gap consists of several quenched spark electrodes separated by mica discs, which may be seen in Figure 285. As a primary inductance a flat copper spiral is used in series with a small cop per variometer, which serves to tune the primary and secondary circuits. The primary circuit is designed for the three fixed wave-lengths of three hundred, four hundred and fifty, and six hundred metres.

The secondary circuit consists of the aërial and aërial lengthening coil, the latter being marked for the wave-lengths given above. The connection for any particular wave-length is made by a switch common to both circuits. Resonance between the circuits is indicated by maximum reading of a hot-wire ammeter.

The receiver is built into the upper part of the apparatus cabinet, and a change-over switch making the necessary connections for receiving or sending is provided.

Variation of wave-length for receiving is carried out by means of a cylindrical sliding coil which is in parallel with a detector and a one thousand-ohm telephone, the latter being shunted across a blocking condenser in the usual manner. Duplicate detectors are provided, either of which may be put in circuit by means of a small detector switch, and during transmission both detector circuits are broken, to guard against damage to them. The wave-range of the receiver, with an aërial eighty metres in length, is from three hundred to nine hundred metres. The telephone is built into a heavily padded helmet, similar to that shown in Figure 282, to deaden the noise of the aëroplane motor.

THE AIRSHIP STATION.

The apparatus of which the airship station consists are mounted in a wooden cabinet, which is divided by means of a vertical partition into an open front section and a closed back section.

In the front open half (shown in Figure 284) are all the separate parts of the transmitter and receiver which have to be operated or adjusted by hand, while the back closed half of the cabinet contains all those parts of the transmitter which need no attention, such as the self-induction and capacity.

The aërial winch is mounted on four porcelain insulators on the top of the cabinet. On this winch a phosphor bronze aërial wire three millimetres in diameter and about two hundred metres long is wound. The wire is wound off by means of the insulated hand crank to suit the wave-length chosen, a counter showing the number of metres paid out. The wire passes over insulated pulleys over the edge of the car and hangs down freely. The crank, pawl, brake, counter, and drum of the winch are heavily insulated. Outside the cabinet on the right-hand side are the terminals for the connections from the source of power and for lighting the station. The external dimensions of the cabinet are: Width

about sixty centimetres, depth about thirty-three centimetres, and height about seventy-six centimetres, and the station requires a vertical space of about one hundred and thirty-five centimetres.

An aërial change-over switch, in the cabinet, is arranged so that when in the transmitting position it interrupts the receiver circuits, and when in the receiving position interrupts the main-power circuit, so that the sensitive receiving apparatus is not liable to be damaged by accidental pressing of the key while receiving. The metal frame of the car forms the counterpoise.

The source of power is an alternating current generator with direct-coupled exciting machine. The output of the generator, at about three thousand revolutions per minute is about 500 watts, and the frequency is five hundred cycles per second. The generator is driven from the motor of the airship either by means of a belt or chain, or by means of intermediate gearing with a throw-out clutch.

A voltmeter and a pressure-speed regulator and the necessary fuses are mounted in the cabinet.

The transmitter consists of the following:—Transformer, quenched spark gap, excitation capacity and self-induction, aërial lengthening-coil ammeter, Morse key, and a changing device for three different wave-lengths.

The excitation circuit of the transmitter can be tuned to several waves, ranging from three hundred metres to six hundred metres, but if the airship is flying very low down only the short wave-lengths can be used. For the different wave-lengths corresponding aërial coils, fitted with connecting plugs for specified wave-lengths, are connected in the antenna. Exact tuning is effected by winding off more or less of the antenna wire. The latter is marked with different colours corresponding to the connections on the excitation and coupling coils.

The receiver is a complete aural receiver of a special type designed for airships. The separate parts of the receiver are as follows: Variable self-induction, detector, telephone, blocking condenser, and a blocking switch for the detector. Plug sockets are provided for two telephones. All these parts are mounted in the cabinet.

The whole of the self-induction which is used for increasingthe natural wave-length of the aërial is also used for direct coupling the detector. The detector coupling turns can be varied by means of plugs. The number of turns for lengthening the aërial remains approximately constant for all wave-lengths, so that only the detector coupling turns need to be regulated.

The effective range of the station communicating with a wheeled military station is from one hundred to two hundred kilometres.

The weight of the complete station is about two hundred and seventy-five pounds, the alternator weighing one hundred and twenty pounds, and the apparatus cabinet and winch one hundred and fifty-five pounds. A similar but larger installation, radiating ·3 kilowatt of electrical energy, is also manufactured. The installations described are all built upon the Quenched Spark system; and since this form of spark gap radiates from fifty per cent. to seventy-five per cent. of the primary energy, these stations be may regarded as the lightest and most efficient aërial stations yet manufactured.

SOCIETIES.

THE LONDON ASTRONOMICAL SOCIETY.—A meeting of the above Society was held on Saturday, July 18th. Mr. Worthington gave an address on the probability of life on Mars. He showed that the Polar caps could be composed of nothing other than water substance. He also showed that it was impossible for water to reach the equatorial regions of the planet by any natural means. He came to the conclusion that it was artificially conveyed there. He repeatedly saw canals on Mars during his recent visit to the Flagstaff Observatory, which confirmed his previous observations.

The President, Professor A. W. Bickerton, concluded the meeting with an address on the Progress of Science and Cosmic Evolution.

THE AMERICAN ENTOMOLOGICAL SOCIETY.—The American Entomological Society being desirous of bringing its publications more promptly before entomologists who are not situated near the largér reference libraries, or who desire to build up special entomological libraries of their own, has devised a scheme by which a mutually beneficial coöperation can be secured.

Its Transactions are now beginning Volume XL, and their pages contain papers covering the whole field of entomological activity, aside from purely economic problems now covered by Government support, papers on the general subject appearing, as well as numerous special studies in the various orders.

The price of subscription to the complete volume of the Transactions is four dollars—payable in advance—the issues appearing approximately quarterly. The last two volumes (XXXVIII and XXXIX) of the Transactions contained seven hundred and thirty-four pages and twenty-nine plates. All of the receipts of subscriptions and sales on account of publications are used in maintaining and enlarging the Transactions and such other publications as the Society brings out, so that all funds received from these sources are used solely for the support and betterment of the journals, the subscriber being the one directly benefited.

The Society also sells separates of the varioŭs papers published by it, the price for which is computed on a fixed basis per page and plate, this price being known as the list price.

The Society proposes to enable workers who may not wish for the whole Transactions to subscribe to the separate papers on such orders as interest them. In doing this, it offers a reduction of ten per cent. from the list price to those subscribing to all papers in one or more orders, the payments being due on receipt of the publications.

As an alternative proposition for interested workers who may not wish to secure all the papers of certain orders, but who wish to be in touch with such as are appearing, so that they can secure promptly those they do desire, the Society will send notices, consisting of an abstract of the paper with price, to those who desire such notification.

Particulars can be obtained from the Publication Department, 1900, Race Street, Philadelphia, Pa., U.S.A.

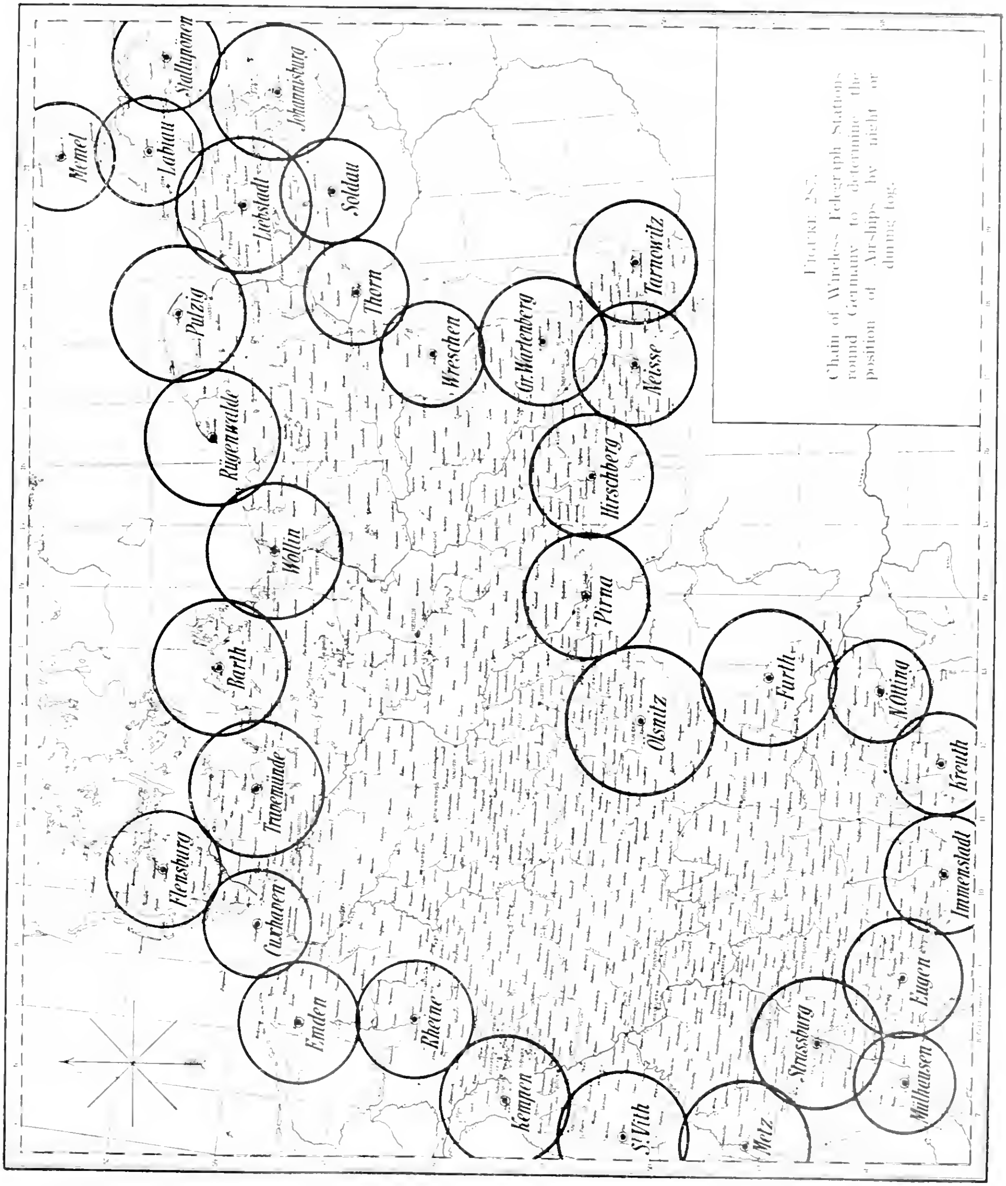


Figure 287.
Chain of Wireless Telegraph Stations round Germany to determine the position of Air-ships by night or during fog.

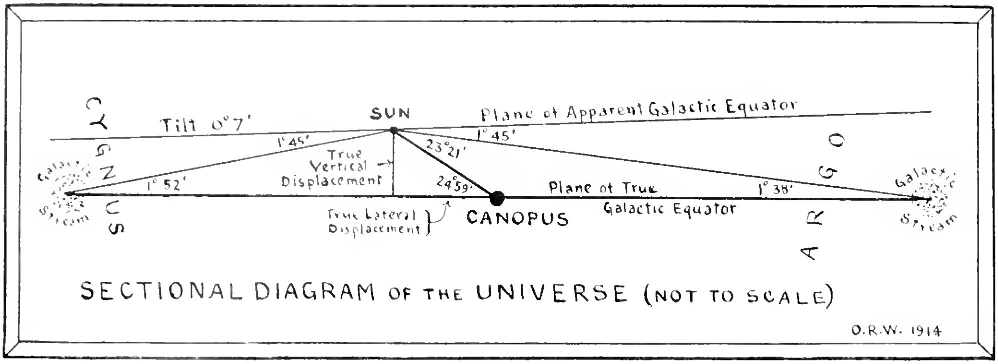


FIGURE 288.

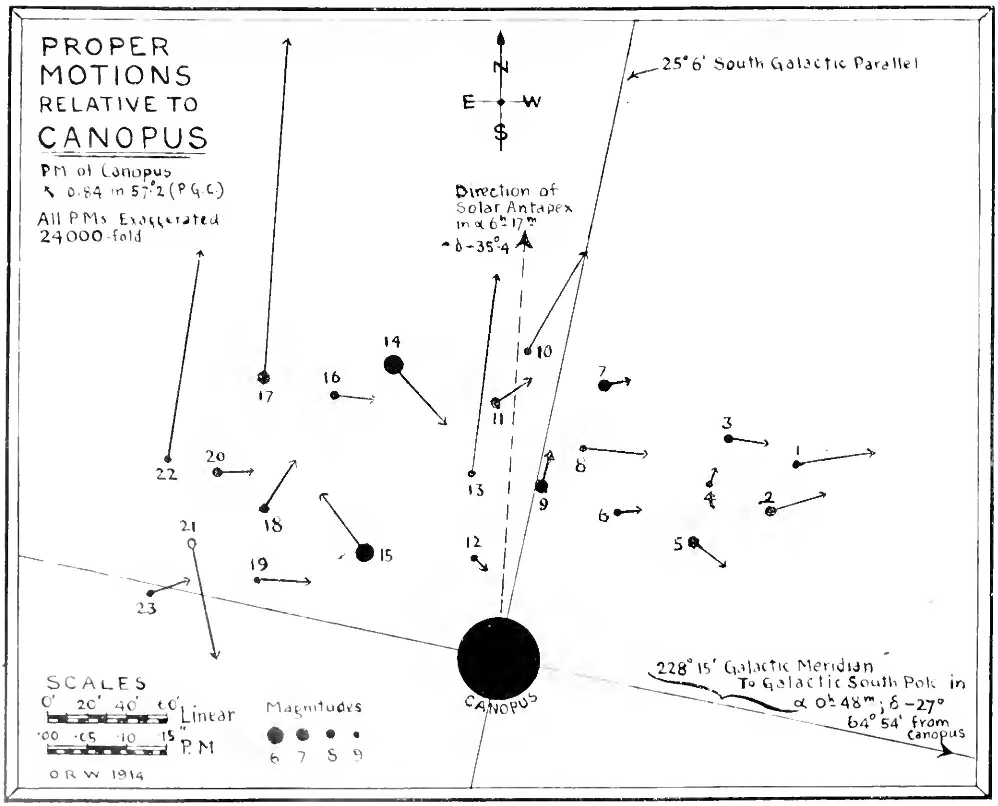


FIGURE 289.

THE SIDEREAL CENTRE.

By O. R. WALKEY, F.R.A.S.

THE Helium or B type, the so-called "Orion," stars are those which recent studies concur in placing at great distances from our system, while their brighter members, too, appear, according to Professor Campbell (*Lick Obs. Bul.*, 195) to lie as fully remote as do their fainter. This peculiarity, together with the rapid decrease, with diminishing magnitude, in the numbers of this class, argues a great average luminosity, coupled with great distance. Further, these stars are found by Professors Campbell and Boss (*Lick Obs. Bul.*, 195; *Astron. Journ.*, 620, 635-6) to be virtually free from that preferential motion, or star-streaming, which seems to be characteristic of the other spectral classes. These stars thus peculiarly invite treatment as of those most truly representing the visible universe, of which they may not unfairly be regarded as the framework.

In a recent study by the writer (*Mon. Not. R.A.S.*, May, 1914) of the distribution of the several spectral classes—particularly of type B—with reference to the galaxy, the relative preponderances of these stars (Oe5 to B5) in galactic latitude and longitude respectively places the apparent centre of their system on the 230° galactic meridian—or of "galongitude," reckoned from the intersection of the galactic and celestial equators in Aquila—and between 20° and 30° south in galactic latitude, or of "galatitude." This, in other words, is the direction from which our solar system appears to lie eccentric within the universe defined by the helium stars. The relatively small number (seven hundred and six) of these stars involved (as given in *Harvard Annals*, Vol. 56, pt. 2) is largely compensated by the generally remote and therefore comprehensive distribution just referred to of this type's brighter members, of which this number is largely composed, and includes them all. The sidereal centre probably lies, therefore, on the line just named, or between α 6h 0m, $\delta - 55°$, and α 6h 55m, $\delta - 52°$. The same studies with the work of Kapteyn, Boss, and Campbell further indicate the distance of this centre as being in the neighbourhood of four hundred light-years, or one hundred and forty "secpars," to adopt under this name the more useful unit of stellar distance corresponding to 1″·0 parallax.*

The association of a particular star with the sidereal centre would, if established, give coherence to the several lines of study now proceeding in stellar motion and distribution, and enable us to realise more clearly their true significance. Accepting the position line defined, it will be found to lie nearly symmetrically across the splendid star Canopus, and the only star within the prescribed limits of which we have any definite knowledge. This star appears to be the greatest sun of which we know anything, and is referred to by Professor See as an example of his hypothesis of condensed star-clusters. In view of this remarkable coincidence the further study of this star assumes a peculiar interest as pertinent to the question of a sidereal centre.

Firstly, as to the distance of Canopus:—the late Sir David Gill found its parallax and proper motion to be insensible with regard to four 8th-magnitude comparison stars, of which the average absolute parallax, according to Professor Kapteyn's table (*Gron. Pub.*, No. 24) is ″·0065. Considering, however, the uncertain application of averages to individuals, further evidence is desirable in support or otherwise of this value, and is best afforded by a study of the cross and radial motions in relation to the solar motion in space. The speed of solar motion and its apex appear to vary slightly, according to the spectral class of the stars to which they are referred. Here, as for their general fixity, the helium stars are the chosen reference for the solar position, so in consistence to them also should the direction and speed of solar motion be referred. Professor Boss (*Astron. Journ.*, 623-4) has derived the solar apex relative to four hundred and ninety of these stars alone, the mean of his two solutions placing the apex in α 18h 17m, $\delta + 35°·4$ (assuming a solar velocity of twenty kilometres a second); while Kapteyn, Campbell, and Stroobant (assuming apices derived from all spectral types, and but little removed from Boss) derive from the B stars solar velocities ranging from 20·7 to 23·3 km./sec.; the mean of these (weighted according to the numbers of stars used) is 21·5 km./sec., and is here adopted with Boss' Apex, of which the antapex lies therefore in α 6h 17m, $\delta - 35°·4$, a point found to lie 21° 9′ south in galatitude (referred to Newcomb's mean north galactic pole in α 12h 48m, $\delta + 27°$). The antapex further lies 17° 15′ northward from Canopus, the speed of apparent or parallactic drift of which (due to the solar motion) becomes 6·37 km./sec. towards this

* The name here adopted is the proposed "parsec," with the syllables reversed to meet the objection lately raised to its implication (by English usage of final syllables) of time or pure arc rather than distance.

antapex. The corresponding radial component (recessional) set up in Canopus is 20·53 km./sec., a figure which almost exactly coincides with the observed velocity of Canopus, 20·6 km./sec. in recession. This indicates Canopus to be stationary with regard to the universe defined by the B type stars.

The annual proper (cross-) motion of Canopus, according to Boss ("Prelim. Gen. Cat."), is ″·0184 in the direction 57°·2, or at 60°·4, with the direction of the solar antapex, whither the parallactic component is therefore ″·0091, while the normal to this line is ″·0160. Taking the parallactic component to represent the parallactic speed previously derived, the absolute parallax of Canopus becomes ″·0067. Apart from the inherent uncertainties of these small quantities (considering, too, Gill's failure to detect proper motion), this figure may be affected in either direction by the component of any real motion which Canopus may have crosswise towards or away from the antapex. The absence, however, of peculiar radial velocity argues the probability that any peculiar motion may be entirely absent, and in any case its crosswise component should not be large enough to affect materially the derived parallax. If, on the other hand, we accept the reality of peculiar motion, there is an hypothesis which is strongly supported by the A type stars, and which may be mentioned, of motion parallel to the galactic plane as brought out by Professor Campbell and applied by Professor Plummer. This hypothesis usually supplies a good criterion of the distance of an A type star. Since Canopus, however, belongs to type F, a class which affords no definite evidence of galactic planar motion, the application of this method fails, as is evidenced, too, by the parallax (″·077)* so derived being inadmissibly large in the face of Gill's careful measures.

The peculiar motion (if any) of Canopus would therefore be at random, in which case it may be used in two ways, according to the assumption involved, to derive the parallax. Assuming (i) Boss' average ratio (*Astron. Journ.*, 614)

$$\frac{\text{parallactic motion}}{\text{whole motion}} = 0{\cdot}7$$

to apply in this case, the resulting parallactic motion (″·0129) yields, with the parallactic speed, an absolute parallax of ″·0096, or a distance of one hundred and four secpars; (ii) that the speed of motion peculiar to this star be 15·3 km./sec., the mean of Campbell's (14·4) and Boss' (16·2) values derived for the F stars, in which case the parallax becomes ″·0050, giving a distance of two hundred secpars. The mean parallax on these two assumptions becomes ″·0073, while the mean by distances is one hundred and fifty-two secpars. Though probably neither of these assumptions is true, yet, being independent and complementary, the truth, in the event of peculiar motion, should fairly lie between them, so that their mean result may be taken as a further index of the distance, and is in striking agreement too with the two previous estimates as the tabulated results show.

DISTANCE OF CANOPUS.

Estimate by	*Parallax.*	*Distance.*
Comparison Stars	″·0065	154 secpars
Parallactic Motion	·0067	149 ,,
Whole Motion ...	·0073 (by mean)	152 ,, (by mean)

In view of the excellent agreement of these entirely independent estimates, the distance of Canopus may fairly be assumed to be one hundred and fifty secpars, a figure which agrees well too with the order of distance derived for the sidereal centre.

As to the luminosity of Canopus, the R.H.P. magnitude is −0·86, while that of our Sun, if removed to a distance of one secpar, may be taken as 0·0 (implying an actual stellar magnitude −26·57); thus Canopus is actually forty-nine thousand seven hundred times as luminous as the Sun, while its spectrum is class F. Professor Russell and Dr. Shapley have derived from the known binary systems the surface brightnesses of the several spectral types, and which should (they state) be fairly constant for each type. They find the surface brightness of the F stars to be 1·1 magnitude, or 2·75 times brighter than the solar (and with a temperature of 7500° against the solar 5000° C.). The area of Canopus thus becomes eighteen thousand, the diameter one hundred and thirty-four, and the volume two million four hundred and twenty thousand times those respectively of the Sun. Russell and Shapley further find that, on a diagram of surface areas (derived from absolute magnitude with unit surface brightness) for different type stars of unit (solar) mass, the F stars segregate compactly just one magnitude larger than our unit Sun, whence follows a relative density $\frac{1}{(2\cdot512)^{\frac{3}{2}}}$, or 0·25 the solar. Applying this to the bulk of Canopus, its mass becomes six hundred and nine thousand times the Sun's. The chief uncertainty in these values lies in the actual density of such a great sun as Canopus manifestly is. The mutual attraction of so large a volume of gas thus presented would give rise to a set of conditions surpassing anything with which we are acquainted; the tendency, however, should be to increase the density and consequently the mass, of which therefore six hundred thousand times the Sun may be

* Using the general values of solar motion and its apex, as used by Plummer, the parallax reduces to ″·032, a value still too large, however.

fairly set down as the lower limit.* A previous estimate, by the late Mr. Gore, of the Canopic mass, based on a parallax of ″·01, from comparison with Procyon (F5 spectrum), made it a million times the Sun. This estimate, though agreeing well with the present one, rests on one star alone, and that of a spectrum not exactly similar.

Given such a mass, its effect should be evident in the relative motions of the faint stars amongst which it is situate. In order to apply some such corroborative test, a region was chosen extending from 6h 4m to 10m in R.A., and from 50° to 55° in south declination, representing an area some five degrees square around Canopus, and all the stars of the Cape and Sydney astrographic catalogues within these limits were plotted. The proper motions of those in the southern belts (below −52° and allotted to Sydney) are, unfortunately, not reduced, so that only those (Cape) stars between −50° and −52° having assigned motions† appear in Figure 289, supplemented for brighter stars from Boss' "Preliminary General Catalogue." Figure 289 consequently shows twenty-three stars (numbered in order of R.A.) in the northern vicinity of Canopus, to which their cross-motions have been reduced relative. Resolving these tangentially and radially, and reckoning their components positive according as they are respectively clockwise around and away from their primary, the mean tangential component is found to be ″·0505 (clockwise) as against ″·0344 (outward) mean radial motion. Of the tangential components only two are negative and one zero, while their stated mean represents eighty-three per cent. of the mean whole motion. This, coupled with the fact that the negative radial components confine themselves to one side (west) of their primary, appears to afford evidence of orbital motion enough to justify a closer study in weeding out any stars plainly extraneous to any presumable sub-Canopic system. An inspection of Figure 289 will eliminate Nos. 10, 13, 17, and 22, as having large proper motion, and apparently sharing the drift of the more rapid of Kapteyn's two-star streams (that towards α 90°, δ − 12°), their large p.m. arguing a common greater proximity to our system. On this score No. 21, with ″·15 in the opposite direction, should also be excluded.‡

The relative motions of the remaining eighteen stars, as of those at presumably the same order of distance, will remain unaffected by the component of solar motion, and, as possible satellites to Canopus, present the following quantities, which have been derived as simple means as sufficiently approximate, considering the inherent uncertainties of our data:—

Canopic System.

Mean distance from Canopus...	D	133′·1
Mean tangential component (clockwise) ...	T	″·0341
Mean radial component (outward)	R	″·0042
Mean inclination to radius-vector $\tan^{-1}\frac{T}{R} = \theta$		83°·0
Minimum mass (times the Sun)		794,000

The angle θ expresses in its approach to 90° that towards the condition of satellites symmetrically placed in a common orbital plane, or of circular motion in a plane normal to the right line. This latter case, if true, would represent the minimum mass $M = DT^2$ when at a distance of one hundred and fifty secpars, D represents one million two hundred thousand astronomical units, and T fifteen miles a second, or 0·81 of the Earth's mean orbital speed. This mass and that previously derived depend alike on the adopted distance of Canopus, of which their mutual relation is consequently independent. Though necessarily provisional, the striking agreement—after due allowance for coincidences—of the two entirely independent estimates of the minimum mass constitutes a somewhat forceful case for the reality of orbital motion for the faint stars in the vicinity of Canopus. This of course cannot be accepted as fact until we have the evidence of such stars of the −52° to −55° belt in the southern vicinity of Canopus, as may reasonably lie at the same distance. The reduction of these motions is therefore highly desirable, as invested with a peculiar interest.§

There is in this connection one point to be observed, namely, that "forward" orbital motions distributed in all planes around their primary will appear "forward" or "retrograde" according as their stars lie on the near or far side of their primary. The settlement of the question thus awaits the development of appliances able to measure the radial velocities of these faint stars.

The actual mass of Canopus will be anything greater than the figure derived, according to the

* One source of uncertainty, that affects some of the quantities derived, is the adopted stellar magnitude of the Sun. Russell adopts one 0·3 magnitude brighter, evidently following the Harvard reduction −26·83. Substituting this for the (unital) −26·57 figure, the luminosity of Canopus reduces to the actual value 39,100, the area to 14,200, diameter to 119, and bulk to 1,691,000 times these solar quantities; the density, on the other hand, increasing to 0·36 the solar, leaves the mass unchanged, and independent therefore of the adopted stellar magnitude of the Sun.

† The four comparison stars used for determining the parallax of Canopus are excluded as being assigned no motion, their mean motion being indistinguishable from that of their primary; a result to be expected in the case of more or less symmetrically placed "satellites," if such at all.

‡ Other stars, such as Nos. 1, 14, and 15, might further be omitted; such exclusion, however, is scarcely warranted in view of the uncertainties of small p.m.'s, while their exclusion effects no appreciable change in the resultant quantities.

§ The two stars of known p.m. in this region, δ Pictoris (4·8 magnitude) and G Carinae (4·4 magnitude), have nearly equal and parallel motions (counter-clockwise), which implies a common drift and considering too their brightness, and being only two in number, they supply no real criterion.

mean orbital inclination (i) to the line of sight.* The most reasonable index as to this will follow from the assumption of random orbital inclination, whence integrating $\sin^3 i$ (by the inverse of which the mass varies) gives a mean value ·589: this, divided into the minimum mass, gives one million three hundred and fifty thousand times the Sun as the probable actual mass of Canopus.

A curious result which follows from this is that such a mass, acting at one hundred and fifty secpars, would of itself produce in our Sun's motion a tangential component of 3·86 miles or 6·21 kilometres a second. When we consider that the actual crosswise component of solar motion is 6·37 km./sec., the striking agreement, which it seems hard to believe entirely coincident, impresses itself in confirmation of the foregoing hypothesis. Again, this agreement of the estimate with the fact supplies an indirect confirmation of the distance of Canopus, since this is ultimately a direct function of the velocity.†

The mass necessary at one hundred and fifty secpars to produce the actual crosswise solar component would be one million four hundred and twenty thousand Suns. The close agreement of these estimates implies that the combined attraction of the lesser suns around us is balanced in this respect—a state of affairs which, if continuous, would indicate for our Sun a highly eccentric hyperbolic orbit in a plane nearly perpendicular to the celestial, and having its "outer" focus distant one hundred and sixty secpars in the direction α 6h 14m, δ − 18° 10′ (a degree west of β Canis Majoris), towards which point, therefore, the solar antapex would imperceptibly shift with the lapse of time. As a matter of curiosity—for it assumes continued absence of disturbing forces—the elements of the hyperbola derived are given as follows :—

Eccentricity	8·52	
Angle between asymptotes ...	166½°	
Direct axis	10·9	secpars ; inclined 13° to galactic plane
Conjugate axis	92·3	secpars ; inclined 23° to galactic plane
Parameter	780	secpars ; inclined 23° to galactic plane
"Perihelial" distance ...	41·0	secpars
Epoch since "periastral" passage	219×10^{12}	years

Needless to say, the final item is imaginary of the present creation being then existent ! The angular divergence of the asymptotes indicates (in its supplement) that the ultimate deviation of the solar path due to Canopus is thirteen and a half degrees from the straight line.

The several indications in favour of the present hypothesis may now be summarised as follows :—

(i) Canopus occupies the approximate position derived for the centre of the stellar system, as defined by the remote helium stars.
(ii) Its distance is of the same order as that indicated for this helium star centre.
(iii) Canopus appears to be stationary with reference to these virtually "fixed" helium stars.
(iv) Its predominant luminosity and mass are in character with their suggested significance.
(v) The relative motions of the faint stars, so far examined, in the vicinity of Canopus indicate an orbital motion confirming the independently derived mass.
(vi) The component of solar motion tangential to Canopus indicates the existence of such a mass at the given distance.

Two other features, which may prove relevant, are :—

(*a*) The objectives (α 90°, δ − 12° and α 263°, δ − 60°) of Kapteyn's two star-streams (assuming their reality) lie on either side of Canopus at angular distances inversely proportional to their respective speeds, and in nearly the same apparent south galatitude as Canopus.‡
(*b*) The solar antapex lies in nearly the same apparent south galatitude.

It will, of course, be clearly understood that none of the foregoing indications are set forth as in any way *proving* the central position of Canopus, the indication in some cases being within its own limit of error. They nevertheless point consistently in the same direction, though mutually independent, so that, however slender may be each cord in itself, yet, collectively, they assume that comparative strength which the cable bears to its component strands. As a chain of mere coincidences in a common direction, the foregoing indications would be scarcely less remarkable than the fact it is suggested they demonstrate.

Finally, the central position of Canopus may, if established, be used to determine the galactic distances in terms of the Sun-Canopus line, which would thus serve for the sidereal system the purpose served by our astronomical unit (Earth-Sun line) for the solar system. The diagram in Figure 288 exemplifies the principle, while the table summarises the resultant distances relative to the unit line, and absolutely in secpars and light-years. The quantities follow from the apparent southward deviation 1°·75, derived by the late Professor Newcomb for the main galactic stream in connection with the apparent south galatitude 25°·1 of Canopus,

* For instance, suppose all the companion stars to lie in the true galactic plane, and therefore inclined at 25° to the sight line, the actual mass would then be :

$$\frac{\text{minimum mass}}{\sin^3 i} = \frac{794{,}000}{\cdot 08} = 9{,}920{,}000 \text{ Suns.}$$

† Velocity $\propto \sqrt{\dfrac{\text{mass}}{\text{(distance)}}}$; mass $\propto$ (distance)^3,

whence velocity $\propto \sqrt{\text{(distance)}^2} \propto$ distance.

‡ The galactic meridian of Canopus bisects the remarkable assemblage of helium stars in a belt 10° wide between 200° and 260° in galongitude, and comprising about a quarter of the present count for the whole sky.

relative to the plane having its N. pole in α 192°, $\delta + 27°$.*

GALACTIC DISTANCES.

Quantity.	*Unital.*	*Secpars.*	*Light-years.*
Sun to Canopus	1·00	150	489
To Galaxy in Cygnus ...	12·98	1950	6330
To Galaxy in Argo ...	14·80	2220	7220
True Galactic Radius ...	13·88	2080	6780
Vertical Displacement of Sun	0·422	63·3	206
Lateral Displacement of Sun	0·906	136	442

Our eccentricity within the galaxy is therefore vertically $\frac{1}{33}$ and horizontally $\frac{1}{15}$ of the galactic radius, while the figure derived for this radius, corresponding to a parallax of ″·0005, follows the trend of recent indications by other methods.

While considering the distance of the galaxy, an independent and rough index of this is supplied from the average actual luminosity in terms of our Sun of the Type II (F, G, K) stars, of which class Fath's integrated spectrum (*Ap. Journ.*, Volume 36, page 362) indicates the galaxy mainly to consist.† According to all the recent studies embodied in Professor Russell's " absolute magnitude " diagram, these stars average at 0·8 " sun-power," and, taking these to be represented by the average galactic star of apparent magnitude 17, their mean parallax becomes ″·00045, giving a distance of two thousand two hundred and thirty secpars, or seven thousand two hundred and fifty light-years, which strikingly confirms the present estimate, and consequently the suggested Canopic hypothesis on which it rests.

There is, to conclude, one factor not to be ignored, and which, though at first sight irrelevant, yet, if established, should be decisive on the question of visible galactic distances, and that is the date of Creation. If the true interpretation of the period named in the inspired account (Genesis i) be six literal days—for which the Hebrew evidence seems strong—and if, again (though the evidence is not so definite), these days apply to the original creation named in the first verse (and not to any subsequent six-day " reconstruction," allowing an indefinitely long interval between this verse and the next), then it should follow that we cannot yet have received the light of stars lying beyond some six thousand light-years, or eighteen hundred secpars. One test, however, which will occur to those who have not committed themselves irretrievably to any one of the modern evolutionary doctrines (involving all ranges in millions of years) is whether, after an appreciable lapse of time, the number of stars down to a limiting magnitude (necessarily faint) tends to show any increase. The time required, however, is likely to be long, seeing that any appreciable increase in the number of suns able to impress themselves at such outlying distances necessitates a considerable proportionate extension in the star-depth, with its corresponding wait in light-years.

The possibilities of the Canopic hypothesis, as they now stand, may be summed up in the suggestion that :—

" The visible Universe, probably of oblate spher-" oidal form, with an equatorial radius of some two " thousand secpars, has its centre marked by the " bright star Canopus, probably the greatest seen " in the Universe, stationary therein, forty or " more thousand times as luminous as our Sun, and " nearly a million and a half times as massive.

" Meanwhile, our Sun, now distant a hundred and " fifty secpars from Canopus, is travelling (from " the influence, apparently, of some original impulse) " at, for the present, just over thirteen miles a " second in a course inclined rather more than " twenty degrees (upwards) from the galactic plane, " and rendered hyperbolic by the influence of " Canopus, which would ultimately deflect it over " thirteen degrees out of the straight. The attractive " effect, meanwhile, of the other stars around may " prove to be generally neutral."

As to what may lie beyond the galaxy, whether or not it be " the waters above the firmament," our boasted knowledge fails as yet to interpret aright the Creator's meaning therein expressed, while speculation becomes a useless search to be " wise above what is written." Meanwhile, as we work towards the true interpretation—whether we ever attain it or not—let us not forget to mark each step of our advance with that ascription of praise properly due to the One Who " telleth the number of the stars and calleth them all by name " ; Whose right hand, further, " hath spanned the heavens, and causes them to stand up together at His call." Thus may we, with increasing intelligence, join in the Heavenly ascription :—

> " Thou art worthy, O Lord, to receive glory and honour and power : for Thou hast created all things, and for Thy pleasure they are and were created."

* This pole seems to give the simplest representation of the truth, being the mean of Newcomb's reductions ; Newcomb's pole for the main stream alone lies in α192°·8m, δ+27°·2, the deviation of which, however, from that adopted here leaves the mean southward dip unaffected.

† This would seem to dispose of Professor See's exceptional estimate of a million light-years galactic distance, based on the assumption that the galactic stars are type B of nearly one thousand " sun-power."

THE PHYSICAL CONDITIONS OF THE JEWISH RACE.

By ISRAEL COHEN, B.A.

(Continued from page 215.)

THE favourable conditions of health enjoyed by the Jews may be illustrated by examining the degree of their liability to various diseases. Contagious maladies, which work with such rapid and pernicious effects among most peoples, do not attack them at all so seriously, despite the apparent opportunities offered by a Ghetto environment.* In 1909 there was an outbreak of cholera in Vitebsk, in the Russian Pale, which (according to the census of 1897) contains 34,420 Jews and 31,299 non-Jews; but whilst 472 non-Jews were attacked, of whom 219 died, only 186 Jews were attacked, of whom 70 died. The mortality of the Jews was thus only 5, and that of their neighbours 15 per 1000.† The Jews are also more immune than their neighbours from typhoid fever. Thus, in Budapest, in 1886, their mortality from this disease was only 46 per 100,000, whilst that of the Catholics was 66, and of the Lutherans 76.‡ And in New York, during the six years ended May 31st, 1900, their mortality from typhoid was only 9·19 per 100,000, a lower rate than that of any other people. They suffer less from smallpox, as they practise vaccination regularly, and in the epidemic of 1900–3 in New York they were almost completely immune, as they were in the outbreak in Manchester in 1902.§ They are less liable to pneumonia, as their indoor occupations do not expose them to the rigours of the weather or the chilling of the body; and as they are not habitual drunkards they can offer a more effective resistance to the disease. On the other hand, owing to their being mostly townsfolk with indoor occupations, they are very liable to chronic bronchitis and asthma; and heart-disease claims a great number of victims, owing partly to their unusually severe struggle for existence and partly to their containing a large proportion of old persons, who are naturally liable to the malady. In the United States the Jewish mortality from heart-disease is double that of the general population. Rheumatism is also common, and so are varicose veins, especially among women, owing to their general indolence and their frequent pregnancy. A special form of the latter affection consists of haemorrhoids, which are more prevalent among Jews than among other people. This malady is particularly common among the Jews of Eastern Europe: its causation is due to a sedentary life, and is generally attributed to sitting nearly the whole day on the hard benches of the *Beth Hamidrash*, studying the Talmud. Cancer is believed to be less frequent among Jews than among non-Jews, though among the former it is more liable to attack the gastro-intestinal organs. On the other hand, cancer of the breast is less frequent among Jewish than among non-Jewish women.

Whether Jews show any particular immunity in regard to consumption is still a matter of dispute, though the bulk of the evidence would seem to be in their favour. Investigations made in Russia, New South Wales, and London show that the Jews are less liable than their neighbours to this disease. In 1897 the Jewish Board of Guardians of London appointed a committee to inquire into the alleged increasing prevalence of consumption among the Jewish poor with a view to adopting preventive measures, but the inquiry established the fact that there had not been any increase of this disease during the previous fifteen years. Dr. J. S. Billings has shown that the death-rate from consumption in New York and Brooklyn for the six years ended May 31st, 1900, was lowest among the Jewish population; a result confirmed by Dr. M. Fishberg, who has made investigations in the New York Ghetto, showing that the death-rate from this disease was 565·06 per 100,000 among non-Jews, but only 110·56 among Jews.‖ The pursuit of sedentary occupations, such as tailoring and boot-making, in the crowded dwellings of congested districts in big cities would lead one to expect a greater frequency of this malady among Jews; but there are counteracting factors in the careful inspection of their meat, the rarity of alcoholism, the regular cleaning of the house, and their general employment in trades that do not expose them to the inclemency of the weather. The eating of kosher meat and the moderate indulgence in intoxicants would seem to be the two chief causes

* In the Middle Ages the Black Death, which carried off so many thousands of people, left the Jews almost untouched, and hence they were accused of causing the death of others by poisoning the wells.

† *Zeitschrift für Demographie und Statistik der Juden*, 1912, page 63.

‡ J. von Körösi, in "Publikationen des statistischen Bureaus, Budapest" (Berlin, 1898).

§ "Minutes of Evidence," Royal Commission on Alien Immigration, pages 21, 794.

‖ "The Immigrant Jew in America," page 329.

for checking the ravages of consumption. On the other hand, diseases of the digestive organs, such as nervous dyspepsia and diabetes, are rather frequent causes of death, being due largely to excessive anxiety and a lack of proper exercise. Whether Jews are more often attacked by diabetes than their neighbours is another moot point, but Dr. Fishberg has shown that it is mostly a question of the location of the Jews, those in Germany falling easier victims to the malady than their co-religionists in Russia, France, or England.* The extent to which Jews are liable to diseases of the digestive organs is evidenced by the large numbers in which they flock every summer to such watering-places on the Continent as Carlsbad and Marienbad. Of eye-diseases, trachoma is rather frequent among the Jews of Eastern Europe, owing to their insanitary surroundings, but effective measures of prevention and healing have been adopted in recent years in consequence of this ailment being a ground for the exclusion of immigrants seeking to enter England or America. Of skin diseases eczema is said to be more common among Jews than among non-Jews, a phenomenon also due to an insanitary environment. Sexual diseases are notably less common, the comparative immunity being due partly to superiority in moral relations, partly to moderation in intoxicants, and partly to circumcision ; but the favourable position of the Jew in this respect is slowly receding in Western countries in which there is increasing intercourse with the non-Jewish population.

The position of the Jewish child in regard to disease, as can be deduced from its comparatively low death-rate, is strikingly favourable, and is due to the greater devotion and care exercised by the mother both before and after birth. Jewish children succumb less frequently than others to diphtheria, croup, measles, and whooping-cough, but they more often die from scarlet fever. They show a better resistance to infantile diarrhoea, the mortality from which is only about one-third of that among non-Jewish infants. They are also less liable to rickets, atrophy, and scrofula. Striking evidence on this point was given before the Inter-Departmental Committee on Physical Deterioration, by Dr. W. Hall, of Leeds, who found fifty per cent. of the Christian children in a poor school suffering from rickets, but only eight per cent. of the children in a school of the better class, whereas in a Jewish school of poor children he found only seven per cent. attacked by this ailment.†

The liability of the Jews to nervous diseases is a subject of peculiar and pathetic interest. Distinguished by the superiority of their nervous over their muscular system, they are more prone to mental affections than other people in whom the nervous system is relatively less highly developed. According to various authorities, the frequency of mental diseases among Jews is from two to five times higher than among non-Jews. It is chiefly nervous diseases of a functional order, however, to which they are subject, particularly neurasthenia and hysteria, the latter being found among males to a notable degree. Raymond has actually asserted that the Jewish population of Warsaw forms an inexhaustible source of supply of hysterical males for the clinics of the whole Continent.‡ On the other hand, Jews are less liable to organic nervous diseases than non-Jews, thanks to the comparative infrequency among them of alcoholism and syphilis. Their peculiar position in respect to these disorders is due to a combination of historic and social factors. They have had to endure an endless cycle of persecutions ever since their exile from Palestine ; they have been almost exclusively denizens of towns throughout that period, denied the stimulating influx of country blood ; and they have largely been engaged in intellectual or commercial pursuits, and been exposed to the worry and anxiety incidental thereto. These factors, operating for so long a period, and over so wide an area, have rendered the Jewish nervous system peculiarly susceptible of attack, and they continue to exert undiminished sway to the present day throughout Eastern Europe. The persistent espionage and oppression, the chronic pogroms, and the daily fear of their recurrence, to which the Jews in Russia are exposed, have wrought disastrous effects among them—driving hundreds, nay, thousands, into an incurable state of insanity. According to the Russian census of 1897, the Jews had 9·84 mentally diseased in every 10,000, whilst the Russians had only 9·54, and the Poles 8·51.§ This unfavourable proportion has probably since become worse in consequence of the wholesale massacres of Jews in the autumn of 1905 and the sporadic outrages that broke out in the following year, the type of affection to which they are subject being more frequently melancholia rather than mania. In addition to these factors, one must also take into consideration the early age at which the Jewish child begins his education. His religious, if not his secular, education begins as early as the age of four or five, and throughout the greater part of Eastern Europe it is conducted mostly in an overcrowded and ill-ventilated room, which often forms the entire home of the teacher. An important point that must be borne in mind, however, in regard to the comparative frequency of insanity among Jews is that they are almost exclusively an urban population, whilst almost half of the non-Jewish world lives in the country. Thus a Jewish lunatic must invariably be brought into a public asylum, a necessity that operates to a less degree in the case

* "Jewish Encyclopaedia," Volume IV, article "Diabetes."

† *Jewish Chronicle*, August 19th, 1904.

‡ "L'Étude des Maladies du Système nerveux en Russie" (Paris, 1889), page 71.

§ "Die sozialen Verhältnisse der Juden in Russland" (Berlin, 1906), page 68.

of Gentile lunatics, and hence the disproportion between recorded Jewish and non-Jewish lunatics can to a certain extent be discounted. Despite the relatively high degree, however, in which Jews are attacked by nervous ailments, they are comparatively free from the severer or fatal forms of these diseases. Thus the mortality of the Russian Jew in New York from nervous maladies in the six years ended May 31st, 1890, was 117·68 per 100,000, whilst that of the Bohemians was 336·76, of the white Americans 293·48, and of the Irish 242·14.

Although insanity is the most potent predisposing cause of suicide, self-destruction is, on the whole, comparatively rare among Jews. The reason is to be sought in the controlling influence of religion, which is a recognised deterrent of self-murder, as well as in the traditional view of the Jew in looking upon life as something sacred. Throughout the crowded Jewish centres in Eastern Europe, where orthodoxy has its stronghold, suicide is a very infrequent phenomenon: only in periods of pogroms, when Jewish wives are dishonoured and Jewish girls are deflowered,* is there a notable manifestation of suicidal tendency. The cause is certainly sufficient. There is an appreciable difference, however, in the rate of suicide among different grades of Jewish society, its incidence being much more frequent among the rich than among the poor. Thus, in Austria, where the economic position of the Jews is low, the number of suicides is 20 per 100,000, and in Galicia, where the Jews are even worse off, it is 10 per 100,000, whilst in Baden and Bavaria, where they are on the whole in comfortable circumstances, the rate is 140.† The most significant feature in regard to self-murder among the Jews is its comparative increase in Western Europe and America, thus displaying one of the deleterious influences of modern civilisation upon Jewish life. In these Western lands, where the struggle of life is keener, and the bases of faith are weaker, the despair of the Jew finds a quicker outlet in self-destruction than in the Jewish centres of Eastern Europe, where there is not only a stronger faith in Providence, but where also the social stigma attaching to the family of a suicide acts as a potent deterrent. The increase in the rate of suicide in Western Jewry has become most striking during the last fifty years, the period that has witnessed the growth of emancipation and westward migration; and it is particularly noteworthy in Prussia, where the statistics of the ten years 1890–1901 show that, whilst the rate among the non-Jewish population of that country has remained almost stationary, it has increased among the Jews from 18 to 32 per 100,000.

Although modern Jewry has such a favourable record in regard to mortality and disease, it has a remarkably diminishing birth-rate, which is lower than the birth-rate of the general population in all the countries of Europe. Thus, in Prussia, Bavaria, and Hesse together, the average Jewish birth-rate sank from 31·6 per 1000 in 1876–80 to 17·6 in 1901–1910, and in Prussia alone, in 1911, it was as low as 15·4.‡ This contrasts very unfavourably, not only with the Christian birth-rate in Prussia, 29·7 per 1000, and with the general birth-rate for Germany, 28·7, but also with that of France in 1911, 18·9, which is commonly regarded as the lowest birth-rate in Europe. In Austria the Jewish birth-rate declined between 1899 and 1909 from 35·72 to 28·80 per 1000, and in Hungary between 1901–5 and 1906–10 from 31·1 to 28·6, falling again in 1911 to 26·9 (compared with 35·1 per 1000 of the general population).§ Even in countries farther east, where traditional piety still has its stronghold, the ancient ideal of being fruitful and multiplying is steadily waning. Thus, in Galicia, the Jewish births between 1899 and 1909 declined from 41·41 to 34·40 per 1000 (probably partly due to the large emigration); and in Roumania, between 1903 and 1910, they declined from 32·29 to 29·33, whilst the birth-rate of the general population increased from 40·14 to 50·11;|| and in Bulgaria, between 1891–95 and 1907, they declined from 37·58 to 32·27, whilst the birth-rate of the general population rose from 37·49 to 43·85.¶ The same phenomenon has also manifested itself in Russia, where between 1900 and 1903 the Jewish birth-rate declined from 36·14 to 29·13, which contrasts strikingly with the birth-rate of the Greek Orthodox, 51·3 per 1000;** and in Poland likewise the Jews have the lowest birth-rate, 30, of any denomination, that of the Greek Orthodox being 43·26 per 1000.

This diminution of the birth-rate has altered the composition of the Jewish family, for whilst most families contained from four to six children even as recently as twenty years ago, they now have only from two to four, and there is an increasing tendency to restrict the number to two. The cause of this diminution is mainly to be found in the increase of celibacy and the postponement of marriage, with the consequent curtailment of the period of fertility, due to the increased standard of comfort and education; whilst a subsidiary cause consists in the prudential restraints and the sterilising effect of nervous irritability prevalent among educated classes. These causes operate, it is true, amongst nearly all town dwellers, Jewish or Gentile; but the Jews are almost exclusively a town people, whereas the Christians are to a large extent a rural folk, whose high birth-rate counterbalances the low birth-rate of the town population. To such a

* "The Immigrant Jew in America," page 299.

† "Jewish Encyclopaedia," XI, article "Suicide."

‡ *Zeitschrift für Demographie und Statistik der Juden*, 1913, January and September.

§ *Ibid.*, 1912, pages 78 and 135; 1913, page 118.

|| *Ibid.*, 1912, page 16.

¶ *Ibid.*, 1911, page 17.

** *Ibid.*, 1911, pages 39–44.

degree has celibacy now spread in modern Jewry that its marriage-rate has sunk below that of the Christian population almost throughout Europe. In Germany, in 1911, the marriage-rate of the general population was 7·80 per 1000, but that of the Jews was only 7·08; and in Hungary, in the same years, the figures were respectively 9·2 and 8·3 per 1000.* The same phenomenon has also manifested itself farther east. Thus, in Bulgaria, in 1907, the marriage-rate of the general population was 9·88 per 1000, but that of the Jews only 7·13;† and in Roumania, in 1910, the figures were respectivly 9·44 and 6·09 per 1000.‡ In Russia, too, the traditional idea of founding a family is on the wane: thus in 1903, whilst the marriage-rate of the Mahommedans was 11·4 per 1000, and that of the Greek Orthodox 9·2, that of the Jews was only 7·2, and in Poland it was as low as 6·1.§

The diminishing birth-rate of the Jews is partly counterbalanced by their low rate of mortality, but the advantage that they possess in this respect is limited in effect, and the net result is a lower rate of natural increase than that of the general population. Thus, in Germany, in 1905–10, the general population increased by 7·06 per cent. (the Protestants by 6·23 and the Catholics by 7·74 per cent.), whilst the Jews increased only by 1·47 per cent. In Holland, in 1899–1909, the general population increased by 14·77 per cent., but the Jews only by 1·12 per cent. Similarly, in Austria (1901–10) the addition to the general population was 9·26 per 1000, whilst the Jewish increase was only 7·25, and in Galicia, in the same decade, the Greek and Roman Catholics increased by 8·67 and 11·64 per cent., whilst the Jewish increase was only 7·62 per cent.; in Roumania (1910) the figures were 14·82 and 12·13 respectively; and in Russia (1903) the addition to the Greek Orthodox population was 19 per 1000, whilst that of the Jewish population was only 14·8 per 1000. The effect of this diminishing rate of increase is that the Jews form a diminishing proportion of the general population in many European countries where there is no powerful stream of immigration. In Germany, in 1870, there were 125 Jews in every 10,000 of the population, but in 1910 there were only 95. This diminution was also partly due to apostasy and emigration, and it would even have assumed larger proportions but for the influx of Jews from Eastern Europe. Similarly, in Austria, in 1890, there were 178 Jews in every 10,000 of the population, but by 1910 the proportion fell to 159;¶ and in Italy, between 1861 and 1901, the proportion fell from 13·31 to 10·96 per 10,000 of the total population.** The declining rate of increase of the Jews is in itself an ominous sign for the future; whilst the diminishing proportion which they form of the general population in so many countries is a further disquieting factor, as it exposes them in a steadily increasing measure to the forces of assimilation.

* *Zeitschrift für Demographie und Statistik der Juden*, 1913, page 119. † *Ibid.*, 1911, page 17.
‡ *Ibid.*, 1912, page 16. § *Ibid.*, 1911, pages 39-44.
‖ *Ibid.*, 1911, page 166. ¶ *Ibid.*, October, 1912. ** *Ibid.*, 1905, January.

CORRESPONDENCE.

HIGH TIDE AT FREMANTLE.

To the Editors of "KNOWLEDGE."

SIRS,—Your correspondent, Mr. W. Gornold, and his would-be helpers are hopelessly at sea, which is only to be expected perhaps on a question concerning tides.

None of them seems to be aware of the fact that "Fremantle," Australia, is spelt with only two "e's."

They all speak of a single tide per day as the normal state of things, and agree that Southampton has two. This is wrong. The normal number is two per day, but here at Southampton we have four.

The exceptional state of things at this port is one of the chief causes of her prosperity. It goes on all the year round, and is not limited to the syzygies, as stated by Mr. Gornold. Neither is it confined to Southampton. Havre, St. Malo, Portland, and Selsea Bill all share in this curious phenomenon, while outside these limits it gradually becomes less marked as one proceeds up or down Channel, until it is at length lost at Dover and Land's End.

The cause of these remarkable double tides is most interesting and instructive. The main tidal wave which is born in the Atlantic, and prevented from following the Moon by the deflecting land masses of the American Continent, finds its way across to the British Isles, where it splits into three branches. One of these loses itself in the Irish Sea. Another enters the English Channel, and gives us our first high water. The third branch is the cause of the abnormality. It passes right round by the west and north of Ireland and Scotland, enters the North Sea, and meets the second branch at Dover just twelve hours late. It is thus in time for the next ordinary high water there, and no abnormality is apparent, therefore, until it enters the Channel, and begins to make its way to the westward, when its ever-increasing lateness becomes manifest, and a double tide is seen. This west-going branch then gives us our second high water two hours (apparently) after the normal tide. It is really fourteen hours late, however, and as it proceeds down Channel past Portland and Weymouth the gap between the first and second floods gets wider and wider until ultimately the effect is that of a double low water, known locally as the "gulder."

It is absurd to drag in an "astronomical factor" to explain a purely local irregularity, which must of necessity be terrestrial in origin. Any such factor, *e.g.*, Syzygy and R.A. (M——), cannot be limited to a particular spot on the Earth's surface, but must affect the whole ocean at once. The only reference to astronomy needed is the time of the Moon's Meridian Passage (upper or lower). The interval between that and the time of high water is given on charts and in tide-tables, and is called the "Establishment of the Port," or, as the sailor says, "High Water Full and Change."

Any departure from the regularity of this Establishment is to be explained by local causes, and these are legion. I have gone pretty fully into one only. Others can be found in the Admiralty Tide-tables (1/6).

A. E. LARKMAN.

LARKMAN'S ACADEMY,
SOUTHAMPTON.

THE TWILIGHT ARC.

By MAXWELL HALL, M.A., F.R.A.S.

(*Kempshot Observatory, Jamaica.*)

In an article on the "Colours and their Changes at Sunset on a Tropical Island" in "KNOWLEDGE," Volume XXXVI, page 51, reference was made to some difficulty in discriminating between the last of the Twilight Arc in the evening, or its commencement in the morning, and the base of the Zodiacal Light; and, indeed, if the axis of the latter is much inclined to the horizon, it seems impossible to do so; but when the axis of the light is nearly perpendicular to the horizon, and when the sky is clear down to the very horizon, observations can be made which lead to their discrimination.

Now the breadth of the Zodiacal Light and the length of the Twilight Arc along the horizon depend on the clearness of the air; but when the Sun is 21° below the horizon we may take the breadth of the base of the light to be about 32°, and consequently we never see either the last or the commencement of the Twilight Arc, for they are lost in the glow of the former.

We are therefore obliged to measure the angular length of the arc along the horizon, and to deduce from the length the altitude of the highest point of the arc above the horizon; and this altitude converted into hour-angle will give the reduction of the observation to the time when the highest point of the arc was on the horizon, or 90° from the zenith.

These moments of time lead to the computation of the greatest height in the atmosphere where the air has the power of reflecting the light of the Sun; they also give us the greatest observed breadths of the Zodiacal Light, which form an important part of a long series of observations I have made on the light itself.

My earlier observations this year on the length of the arc were made on the supposition that there would be no difficulty in connecting its length with its altitude; but it was found that the absorbing power of the atmosphere near the horizon was so great that for a given altitude the observed length was much smaller than the computed length, and that an unknown quantity was thus introduced into the problem.

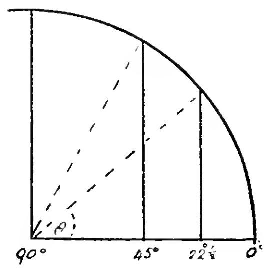


FIGURE 290.

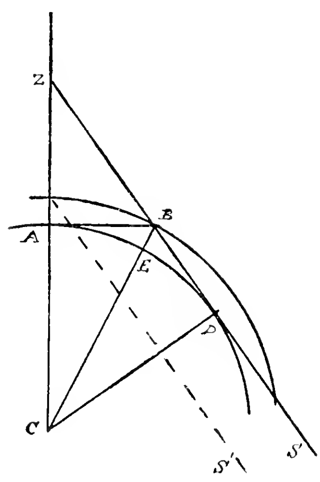


FIGURE 291.

My later observations include different measures taken during the same morning or evening, so as to establish a formula connecting altitude and length based entirely on observation.

Let α be the altitude of the summit of the arc above the sensible horizon, so that α will be measured along the axis of the Zodiacal Light; and let β be the distance from the axis along the horizon to an end of the Twilight Arc; then if α and β be both expressed in degrees, and if θ be an auxiliary angle, it will be found that the observations give

$$\left.\begin{aligned}\alpha &= 7^\circ \sin\theta\\ \beta &= 90^\circ \operatorname{vers}\theta\end{aligned}\right\} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

When β is given, θ is known, and then α; and the time-reduction to the zero of α and β is merely 4α in minutes, omitting small refinements depending on the latitude and the Sun's declination.

The geometrical figure (see Figure 290) corresponding to (1) is also remarkably simple. In this quadrant β is measured in degrees from 0 to 90 along the axis of x; the ordinates at right angles to x multiplied by 0·31 give the corresponding values of α.

And to show that Figure 290 suits our observations we have to compare the differences between the different values of α corresponding to the different values of β. We thus have the following table:—

β		α		Reduction to Zero. min. sec.
15°	......	3° 52′	......	15 28
22½	......	4 38	......	18 32
45	......	6 4	......	24 16
90	......	7 0	......	28 0

This table has been tested; for instance, on

October 24th for $\beta = 15$ the observed altitude of the arc as near as possible to the edge of the Zodiacal Light was about 1°; and for $\beta = 45$ it was similarly about $6\frac{1}{2}$.

And from this table and the table of observations below we obtain the following:—

β		Intervals of Time Observed. min.	Computed. min.
From 15° to $22\frac{1}{2}$°	... ...	4	3
,, 15 ,, 45	... ...	9	9
,, 15 ,, 90	... ...	12	$12\frac{1}{2}$
,, $22\frac{1}{2}$,, 45	... ...	5	6
,, $22\frac{1}{2}$,, 90	... ...	9	$9\frac{1}{2}$
,, 45 ,, 90	... ...	5	4

The differences between the observed and computed times are well within the probable errors of observation; and the equations (1) are therefore as right as we can make them.

In Table 37 the mean local time given in the second column corresponds to β in the third; and then the beginning or end of twilight was found by applying the reduction as explained above. And finally the zenith distance of the centre of the Sun was easily computed.

Analysing these values of z, the Sun's zenith distance, we have:—

β	No. of Observations.	z
15°	7	111 21
17	1	111 17
20	1	112 47
$22\frac{1}{2}$	4	111 24
30	4	111 4
45	8	111 41
48	1	111 31
90	4	111 18

where there is apparently no systematic error. Similarly the eight evening observations give 111° 26′, and the twenty-two morning observations give 111° 27′; so again there is apparently no systematic error. The mean of the whole series of thirty observations is 111° 27′, with a probable error of 6′.

In order to compute the greatest height in the atmosphere where the air has the power of reflecting the light of the Sun, in Figure 291, where refraction has been neglected, let SDBZ be the ray of light which, passing through the atmosphere and touching the Earth's surface at D, is reflected at the greatest height B to the observer at A. Then as $\angle$ ZAS′ = z, we have $\angle$ BAS′ = $z - 90$; $\angle$ ABD

$$= 270° - z; \text{ and } \angle \text{ABC} = 135° - \frac{z}{2}.$$

And if a be the Earth's radius AC, or EC, and h the height of the reflecting atmosphere, BE, we

TABLE 37.

Civil Day. 1912.	Mean Local Time. h. m.	β.	Beginning or End of Twilight. Mean Time. hr. min.	App. Time. hr. min.	Sun's Decl.	Sun's Zenith Distance.
Jan. 4	6 51 p.m.	$22\frac{1}{2}$°	7 10 p.m.	7 5 p.m.	−22 47′	111° 32′
,, 8	6 56 ,,	15	,, 11 ,,	,, 4 ,,	−22 19	,, 13
Feb. 12	7 7 ,,	30	,, 28 ,,	,, 14 ,,	−13 53	,, 36
April 6	,, 21 ,,	,,	,, 42 ,,	,, 40 ,,	+ 6 37	,, 14
,, 7	,, 20 ,,	,,	,, 41 ,,	,, 39 ,,	+ 7 0	110 51
,, ,, ...	,, 29 ,,	$22\frac{1}{2}$	,, 48 ,,	,, 46 ,,	,, ,,	112 26
,, 12	,, 29 ,,	15	,, 44 ,,	,, 43 ,,	+ 8 50	111 1
,, 13	,, 27 ,,	$22\frac{1}{2}$	,, 46 ,,	,, 46 ,,	+ 9 12	,, 33
June 22	4 10 a.m.	30	3 49 a.m.	3 47 a.m.	+23 27	110 35
,, ,, ...	,, 16 ,,	90	,, 48 ,,	,, 46 ,,	,, ,,	,, 47
Aug. 24	,, 35 ,,	45	4 11 ,,	4 9 ,,	+11 11	111 51
Sept. 10	,, 42 ,,	,,	,, 18 ,,	,, 21 ,,	+ 5 2	,, 36
,, 11	,, 44 ,,	,,	,, 20 ,,	,, 23 ,,	+ 4 39	,, 16
,, 21	,, 36 ,,	15	,, 21 ,,	,, 28 ,,	+ 0 43	,, 31
,, ,, ...	,, 39 ,,	17	,, 22 ,,	,, 29 ,,	,, ,,	,, 17
,, ,, ...	,, 46 ,,	48	,, 21 ,,	,, 28 ,,	,, ,,	,, 31
,, 23	,, 37 ,,	15	,, 22 ,,	,, 30 ,,	0 0	,, 18
,, ,, ...	,, 46 ,,	45	,, 22 ,,	,, 30 ,,	,, ,,	,, 17
Oct. 18	,, 35 ,,	15	,, 20 ,,	,, 35 ,,	− 9 33	113 3
,, ,, ...	,, 46 ,,	45	,, 22 ,,	,, 37 ,,	,, ,,	112 35
,, 19	,, 43 ,,	15	,, 28 ,,	,, 43 ,,	− 9 55	111 16
,, ,, ...	,, 51 ,,	45	,, 27 ,,	,, 42 ,,	,, ,,	,, 30
,, ,, ...	,, 55 ,,	90	,, 27 ,,	,, 42 ,,	,, ,,	,, 30
,, 20	,, 40 ,,	20	,, 22 ,,	,, 37 ,,	−10 17	112 47
,, ,, ...	,, 46 ,,	45	,, 22 ,,	,, 37 ,,	,, ,,	,, 47
,, ,, ...	,, 51 ,,	90	,, 23 ,,	,, 38 ,,	,, ,,	,, 33
,, 24	,, 49 ,,	15	,, 34 ,,	,, 50 ,,	−11 42	110 6
,, ,, ...	,, 53 ,,	$22\frac{1}{2}$	,, 34 ,,	,, 50 ,,	,, ,,	,, 5
,, ,, ...	,, 56 ,,	45	,, 32 ,,	,, 48 ,,	,, ,,	,, 34
,, ,, ...	5 1 a.m.	90	4 33 a.m.	4 49 a.m.	−11 42	110 20

have $a + h = a \operatorname{cosec} (135° - \frac{z}{2})$. But refraction has considerable effect, and it may be easily shown that if r be the horizontal refraction this equation becomes

$$a + h = a \operatorname{cosec} \left\{ 135° - \tfrac{1}{2} (z - 3r) \right\} \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

whence h may be found.

Taking $z = 111° \ 27'$, $r = 31'$; and $a = 3961$ miles, we have $h = 60$ miles, and the distance AB very nearly 700 miles.

The depression of the Sun below the horizon at the commencement or end of twilight, namely, 21° 27', and the corresponding height of sixty miles, observed and computed, are much greater than the values usually assigned to them.

We have now to consider the circumstances affecting the base of the Zodiacal Light. From Figure 290 it appears that the form of the Twilight Arc is that of the upper half of a constantly changing elongated ellipse whose semi-axes are β and α respectively, and the form of the Zodiacal Light is that of a tapering cone stretching across the whole sky, but very dim between 120° and 170° from the Sun, when it then slightly increases to 180°. In Figure 294 the arc has been taken to be 32° broad at its base where it meets the arc 21° from the Sun, tapering to 15° about 90° from its base upwards; and Figure 294 gives the appearance of the Zodiacal Light when there is very little diffused light near the horizon and when it is seen at its best.

But when there is much diffused light in the sky, which increases towards the horizon and forms there a white band of considerable breadth, the phenomena are now represented by Figure 295; the shape of the light has been changed, and its base unduly lengthened to about 51° at the same distance of 21° from the Sun.

My earlier measures made some thirty-five years ago gave a figure similar to Figure 295; later observations made some six years ago, when I had much other work to do, even increased the width of the base; the latter observations and their results were published in the *United States Monthly Weather Review* for March 1906. The present series now on hand with leisure at my disposal indicates that when the atmosphere is at its best the light takes the form of Figure 294 instead of that of Figure 295, and allows us to discriminate between it and the Twilight Arc.

But, putting measures aside, the light is a beautiful feature in our tropical morning and evening skies, and deserves far more general attention than it has yet received.

VARIABLE STAR CHARTS.

The American Association of Variable Star Observers offers to all those interested in the observation of variable stars a valuable set of charts, in blue print, of long-period variable stars at a remarkably low price.

These charts, two hundred and forty in number, are a combination of the Harvard College Observatory photographic charts, the Durchmusterung chart enlargements, and charts from Father Hagen's Atlas. In every case comparison stars are designated with light-values reduced to a common standard, that adopted by the Harvard College Observatory.

These charts may be purchased singly at five cents each, or the whole set for ten dollars post paid. The sets are printed on large sheets, ten to sixteen charts to the sheet. The H.C.O. charts are $7\frac{1}{2} \times 10\frac{1}{2}$, the Hagen charts $8\frac{1}{2}$ inches square.

One of the drawbacks to variable-star observing heretofore has been the high cost of the valuable and indispensable Atlas Stellarum Variabilium of Father Hagen. No claim is made that the charts advertised are the equal of the Hagen charts, but they are an inexpensive, serviceable, and valuable set of charts that should be in the hands of all observers of long-period variable stars not provided with adequate or sufficient material. The charts are furnished gratis to all members of the Association, and are offered to other observers through the courtesy of Professor E. C. Pickering, Director of the Harvard College Observatory.

It may be added that the said Association extends a cordial invitation to all observers to join its ranks. Those interested are requested to address the undersigned,

William Tyler Olcott.

Norwich, Conn., U.S.A.

JUPITER'S RED SPOT IN 1913.

The great red spot of Jupiter in June, 1913, was within the south tropical disturbance, and observations made during its passage through that region are of peculiar interest. The mean daily motion of the south tropical disturbance was a little more than 0°·3 during the previous year, and as the motion of the red spot was much less the south tropical disturbance overtook it. Figure 292 shows the preceding white loop of the disturbance and the white oval which marks the position of the red spot. The observation was made with an eleven-inch reflector, magnifying the planet about 360 times; and, as the seeing was good, considerable detail was detected. A small white spot following the red spot bay seems to be a characteristic marking of this region, as it was observed in the same position a number of times during the 1912 apparition of Jupiter. Faint wisps were seen in the red spot, but the spot as a whole seems to be somewhat brighter than last year. According to my observations, the longitude of the centre of the red spot bay was 305° on June 2nd, 1912, and 300° on October 1st, 1912. On April 1st, 1913, it was about 277°, and on May 25th it was 268°. Allowing for a large probable error, because of low altitude and generally bad seeing in April, the motion of the red spot seemed to have greatly increased, as though it was being carried along with the more rapidly moving disturbance in the southern tropics. As can be seen by the drawing, the disturbance, which started in the northern equatorial belt in August, 1912, continued in the form of a number of dark spots, almost evenly placed, extending nearly around the planet.

Nashville, Tenn., U.S.A. Latimer J. Wilson.

FIGURE 292.
Jupiter, showing the position of the red spot (white oval), May 24th, 1913, 20h 42m G.M.T. (See page 298.)

FIGURE 29[illegible].
Photo-micrograph of a piece of Am[illegible]an Red-Gum Wood. × 15 diameters. (See page 313.)

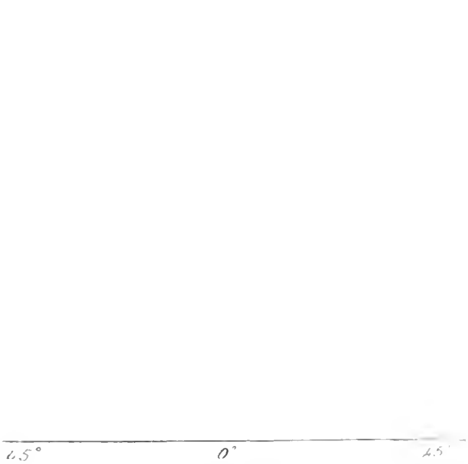


FIGURE 294.
When there is little diffused [illegible] near the horizon.

F[illegible] 295.
When there is m[illegible] diffused [illegible] the horizon.

The appearance of the Zodiacal Light. (See page 29[illegible].)

FIGURE 296. The May Lily in Flower.

FIGURE 29[illegible]. A Bed of the May Lily.

THE MAY LILY *(MAIANTHEMUM CONVALLARIA)*.

By A. R. HORWOOD, F.L.S.

(With Illustrations from Photographs by Stanley Crook.)

THERE is always a charm about a rare flower. It is always likely to have been overlooked in some spot hitherto unknown to anyone; and, if perchance it should be our good fortune to discover a new locality for one of such rarities, it is indeed a red-letter day in our botanical annals.

Such a flower is the May Lily. Very few people, not strictly botanists, as well as perhaps some of the latter, have indeed even heard of it.

The May Lily is perhaps most plentiful at Hackness, about six miles from Scarborough, where it grows in much the same way as the Lily-of-the-Valley in woods. It was formerly to be found in Northumberland, at Howick. Other localities for it now or in the past are: Caen Wood, Middlesex; Dingley Wood, Preston; Harwood, Blackburn, according to Gerard; and Hunstanworth, Durham. It has more recently been discovered in North Lincolnshire.

The natural order to which it belongs is the Asparagaceae, to which also belong the Lily-of-the-Valley, Asparagus, Solomon's Seal, and Butcher's Broom, all but Asparagus, which grows on cliffs, being woodland plants.

It has the Lily-of-the-Valley habit, which is characteristic, several stems being put forth from a slender, creeping rhizome, which enables the plant to spread and to form a patch or bed. Were it not for this characteristic, probably it would ere now have become extinct in some of the few localities where it is found. This feature indeed has saved many an attractive plant liable to be rooted up by the hawker or thoughtless collector. The stems, being annual, die down in winter.

The stem is erect and leafy, with alternate leaves, rather flexuose, and downy or glabrous. The leaves are deeply cordate, triangular, with parallel nerves and short strands at right angles, or campylodromous. The leaves are borne upon short stalks, or petioles.

The flowers are arranged in a raceme, and are small and white, sulphur yellow in bud, the raceme about an inch in length, and unbranched, the short slender pedicels being clustered. They are solitary, or from two to three in number. The parts of the flower are in fours, the perianth-segments being free, and in one series, or there may be six segments in two series; the segments are spreading or reflexed. There are also four or six stamens basifixed on the petals. The flower is suberect and fragrant. There is a single short bifid style, the stigma is blunt, with two or three obscure lobes. The ovules are two in each cell of the two- or three-celled ovary. The fruit is a white or red two-celled berry, which is dotted and small.

The May Lily is the only species of the genus found in Europe, though others occur in America.

While generally growing in woods it is also found in pastures. There is a little doubt as to its being a native except at Scarborough. The illustrations accompanying this article (see Figures 296 and 297) are from specimens growing at Scarborough. They show well the associated habit of the plant. The May Lily varies in height from six to eight inches. It is in flower in May and June.

CORRESPONDENCE.

RUSSIAN PEASANTS' ARITHMETIC.

To the Editors of "KNOWLEDGE."

SIRS,—In reply to the query of the Rev. G. T. Johnston on the Russian method of multiplication I would suggest the following simple proof:

Take a number, say 15. Now $15=2\times7+1$; also $7=2\times3+1$, and $3=2\times1+1$;

$$\therefore 15=2\times7+1=2(2\times3+1)+1=2(2[2\times1+1]+1)+1$$
$$=2^3+2^2+2+1.$$

Any number may be decomposed in a similar manner. Thus, by dividing 25 by 2, it is easily seen that it can be represented in the following way:

$$25=2^4+2^3+0\times2^2+0\times2+1,$$

where the coefficients of 2^2 and 2 are 0.

Now suppose we want to multiply 25 by 11. Arrange the numbers as follows:

$$25=1+0\times2+0\times2^2+2^3+2^4;$$
$$\therefore 11\times25=11+0\times22+0\times44+88+176$$
$$=11+88+176=275.$$

It is easily seen from this why a line is drawn right across when the left-hand number, in Mr. Johnston's example, is even. We repeat the example given by Mr. Johnston, so that the method will be more apparent.

$$\begin{array}{c} 25\times11 \\ \cancel{12\times22} \\ \cancel{6\times44} \\ 3\times88 \\ 1\times176 \end{array}$$

Adding up the figures remaining on the right we obtain 275.

The other example given, 19×17, can be treated in the same way. Thus

$$19=2\times9+1=2(2\times4+1)+1=2(2[2\times2+0]+1)+1$$
$$=2\left(2\left[2\left\{2\times1+0\right\}+0\right]+1\right)+1$$
$$=2^4+0\times2^3+0\times2^2+2+1.$$

Hence $19\times17=17+34+272=323$.

(REV.) M. DAVIDSON.

CANNING TOWN, E.

C

THE FACE OF THE SKY FOR SEPTEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 38.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°
Sept. 5	10 53·9	N. 7·0	23 20·7	S. 1·6	11 15·7	N. 0·3	13 41·1	S. 12·5	21 8·2	S. 17·5	6 3·9	N. 22·3	20 44·0	S. 18·8	8 6·4	N. 19·9
,, 10	11 11·9	5·2	3 13·0	N. 23·2	11 48·0	N. 2·4	14 0·3	14·8	21 6·3	17·7	6 5·3	22·3	20 43·4	18·9	8 7·0	19·9
,, 15	11 29·8	3·3	7 40·0	N. 24·8	12 18·2	S. 1·5	14 19·3	16·9	21 4·6	17·8	6 6·6	22·3	20 42·9	18·9	8 7·6	19·8
,, 20	11 47·8	N. 1·2	12 14·5	S. 4·4	12 46·8	5·2	14 38·1	18·9	21 3·2	17·9	6 7·6	22·3	20 42·4	18·9	8 8·1	19·8
,, 25	12 5·8	S. 0·6	17 8·8	S. 28·0	13 14·2	8·7	14 56·5	20·7	21 2·1	18·0	6 8·5	22·3	20 42·0	18·9	8 8·5	19·8
,, 30	12 23·8	S. 2·6	21 48·7	S. 14·3	13 40·4	S. 11·9	15 14·5	S. 22·3	21 1·4	S. 18·0	6 9·2	N. 22·3	20 41·7	S. 19·0	8 8·9	N. 19·8

TABLE 39.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
Sept. 5	+ 22·1	+ 7·2	207·1	− 21·8	− 18·9	+ 0·2	313·3	111·1	1 17 *e*	8 56 *m*
,, 10	23·2	7·2	141·0	− 15·1	18·8	0·2	23·1	142·7	1 32 *m*	6 0 *e*
,, 15	24·2	7·2	75·0	+ 9·2	18·7	0·2	92·8	174·2	7 19 *e*	7 12 *m*
,, 20	25·0	7·1	9·0	+ 22·1	18·6	0·2	162·3	205·7	7 34 *m*	4 16 *e*
,, 25	25·6	6·9	303·0	+ 5·4	18·5	0·1	231·8	237·0	3 31 *e*	3 24 *e*
,, 30	+ 26·0	+ 6·7	237·0	− 18·0	− 18·4	+ 0·1	301·2	268·3	3 46 *m*	4 37 *m*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}5$, $9^h\ 55^m{\cdot}7$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving southward with maximum speed, it crosses Equator (Autumn Equinox) $23^d\ 9^h\ 35^m$*e*. Its semi-diameter increases from 15′ 53″ to 16′ 0″. Sunrise changes from $5^h\ 13^m$ to $5^h\ 59^m$; sunset from $6^h\ 47^m$ to $5^h\ 41^m$.

MERCURY is an evening star. Semi-diameter 2½″. Illumination nearly full.

VENUS is an evening star, ½ of disc illuminated. Semi-diameter 12″. The fact of its declination being south of the Sun impairs the conditions of observation for northern observers. At East Elongation. 46½° from Sun, on 18th.

THE MOON.—Full $4^d\ 2^h\ 1^m$ *e*. Last quarter $12^d\ 5^h\ 48^m$ *e*. New $19^d\ 9^h\ 33^m$ *e*. First quarter $26^d\ 0^h\ 3^m$ *e*. Apogee $9^d\ 4^h$ *m*. Perigee $21^d\ 6^h$ *m*, semi-diameter 14′ 46″, 16′ 37″ respectively. Maximum librations 11^d 7° S., 15^d 7° E., 23^d 7° N., 27^d 7° W. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 40).

PARTIAL ECLIPSE OF THE MOON.—September $4^d\ 0^h\ 17^m$ *e* to $3^h\ 33^m$ *e*. Magnitude of eclipse 0·863. It is invisible in Europe, visible in the Pacific, Australia, New Zealand, Eastern Asia.

MARS is practically invisible.

JUPITER is in Capricornus, 26′ South of θ Capricorni on 30th. Polar semi-diameter, 21½″.

Configuration of satellites at $9^h\ 30^m$ *e* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.	
Sept. 1	41	○	3	2●	Sept. 16	4	⊙	12	
,, 2	43	○	12		,, 17	4312	○		
,, 3	421	○			,, 18	432	○	1	
,, 4	324	○	1		,, 19	431	○	2	
,, 5	3	○	42	1●	,, 20	4	⊙	32	
,, 6	1	○	234		,, 21	24	○	13	
,, 7	2	○	134		,, 22	12	○	43	
,, 8	1	○	34	2●	,, 23		○	3124	
,, 9	3	○	124		,, 24	31	⊙	4	
,, 10	3 1	○	4		,, 25	32	○	14	
,, 11	32	○	14		,, 26	31	○	24	
,, 12	3	○	24	1●	,, 27	3	○	124	
,, 13	41	○	23		,, 28	2	○	34	1●
,, 14	42	○	13		,, 29	21	○	43	
,, 15	412	○	3		,, 30	4	○	312	

The following satellite phenomena are visible at Greenwich, $1^d\ 10^h\ 5^m\ 56^s$ *e*, II. Ec. R.; $2^d\ 6^h\ 45^m\ 57^s$ *e*,

III. Sh. E.; $4^d\ 0^h\ 57^m\ 15^s$ *m*, I. Oc. D.; $10^h\ 4^m\ 22^s$ *c*, I. Tr. I.; $10^h\ 41^m\ 4^s$ *c*, I. Sh. I.; $5^d\ 0^h\ 21^m\ 51^s$ *m*, I. Tr. E.; $0^h\ 58^m\ 41^s$ *m*, I. Sh. E.; $7^h\ 23^m\ 40^s$ *c*, I. Oc. D.; $10^h\ 20^m\ 9^s$ *c*, I. Ec. R.; $6^d\ 6^h\ 48^m\ 17^s$ *c*, I. Tr. E.; $7^h\ 27^m\ 26^s$ *c*, I. Sh. E.; $7^d\ 2^h\ 19^m\ 12^s$ *m*, II. Tr. I.; $8^d\ 8^h\ 24^m\ 16^s$ *c*, II. Oc. D.; $9^d\ 0^h\ 42^m\ 46^s$ *m*, II. Ec. R.; $7^h\ 8^m\ 34^s$ *c*, III. Sh. I.; $7^h\ 52^m\ 13^s$ *c*, III. Tr. E.; $10^h\ 47^m\ 29^s$ *c*, III. Sh. E.; $10^d\ 7^h\ 50^m\ 31^s$ *c*, II. Sh. E.; $11^d\ 11^h\ 50^m\ 30^s$ *c*, I. Tr. I.; $12^d\ 0^h\ 36^m\ 9^s$ *m*, I. Sh. I.; $2^h\ 7^m\ 54^s$ *m*, I. Tr. E., $9^h\ 9^m\ 52^s$ *c*, I. Oc. D.; $13^d\ 0^h\ 15^m\ 13^s$ *m*, I. Ec. R.; $7^h\ 4^m\ 56^s$ *c*, I. Sh. I.; $7^h\ 37^m\ 7^s$ *c*, IV. Tr. E.; $8^h\ 34^m\ 34^s$ *c*, I. Tr. E.; $9^h\ 22^m\ 25^s$ *c*, I. Sh. E.; $10^h\ 24^m\ 58^s$ *c*, IV. Sh. I.; $14^d\ 6^h\ 44^m\ 1^s$ *c*, I. Ec. R.; $15^d\ 10^h\ 43^m\ 12^s$ *c*, II. Oc. D.; $16^d\ 7^h\ 40^m\ 14^s$ *c*, III. Tr. I.; $11^h\ 10^m\ 2^s$ *c*, III. Sh. I.; $11^h\ 18^m\ 51^s$ *c*, III. Tr. E.; $17^d\ 7^h\ 34^m\ 27^s$ *c*, II. Sh. I.; $8^h\ 31^m\ 40^s$ *c*, II. Tr. E.; $10^h\ 26^m\ 48^s$ *c*, II. Sh. E.; $19^d\ 1^h\ 37^m\ 39^s$ *m*, I. Tr. I.; $10^h\ 57^m\ 6^s$ *c*, I. Oc. D.; $20^d\ 8^h\ 4^m\ 36^s$ *c*, I. Tr. I.; $9^h\ 0^m\ 12^s$ *c*, I. Sh. I.; $10^h\ 21^m\ 56^s$ *c*, I. Tr. E.; $11^h\ 17^m\ 37^s$ *c*, I. Sh. E.; $21^d\ 8^h\ 39^m\ 11^s$ *c*, I. Ec. R.; $9^h\ 44^m\ 20^s$ *c*, IV. Oc. D.; $23^d\ 1^h\ 4^m\ 58^s$ *m*, II. Oc. D.; $11^h\ 11^m\ 30^s$ *c*, III. Tr. I.; $24^d\ 8^h\ 11^m\ 17^s$ *c*, II. Tr. I.; $10^h\ 11^m\ 16^s$ *c*, II. Sh. I.; $11^h\ 3^m\ 25^s$ *c*, II. Tr. E.; $25^d\ 1^h\ 3^m\ 2^s$ *m*, II. Sh. E.; $26^d\ 7^h\ 16^m\ 0^s$ *c*, II. Ec. R.; $27^d\ 0^h\ 45^m\ 26^s$ *m*, I. Oc. D.; $9^h\ 0^m\ 37^s$ *c*, III. Ec. R.; $9^h\ 53^m\ 12^s$ *c*, I. Tr. I.; $10^h\ 55^m\ 33^s$ *c*, I. Sh. I.; $28^d\ 0^h\ 10^m\ 28^s$ *m*, I. Tr. E.; $7^h\ 12^m\ 41^s$ *c*, I. Oc. D.; $10^h\ 34^m\ 20^s$ *c*, I. Ec. R.; $29^d\ 6^h\ 37^m\ 47^s$ *c*, I. Tr. E, $7^h\ 41^m\ 45^s$ *c*, I. Sh. E.; $30^d\ 9^h\ 31^m\ 3$ *c*, IV. Sh. E.

Eclipses will take place to the right of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN is a morning star, in Gemini. Polar semi-diameter $8\frac{1}{2}''$. Major axis of ring $42''$, minor $18\frac{1}{2}''$. Angle $P-6^\circ\cdot2$.

Eastern elongations of Tethys (every 4th given) $1^d\ 5^h\cdot9$ *m*, $8^d\ 7^h\cdot2$ *c*, $16^d\ 8^h\cdot4$ *m*, $23^d\ 9^h\cdot7$ *c*; Oct. $1^d\ 10^h\cdot9$ *m*: of Dione (every 3rd given) $3^d\ 8^h\cdot3$ *m*, $11^d\ 1^h\cdot5$ *c*, $19^d\ 6^h\cdot6$ *c*, $27^d\ 11^h\cdot7$*c*; of Rhea (every 2nd given) $7^d\ 7^h\cdot7$*c*, $16^d\ 8^h\cdot7$*c*, $25^d\ 9^h\cdot7$*c*.

For Titan and Japetus E., W. stand for East and West elongations, I for Inferior (North) conjunction, S. for Superior (South) conjunction. Titan $2^d\ 5^h\cdot9$ *m* I, $6^d\ 3^h\cdot2$ *m* W., $10^d\ 3^h\cdot5$ *m* S., $14^d\ 6^h\cdot3$ *m* E., $18^d\ 5^h\cdot8$ *m* I., $22^d\ 2^h\cdot7$ *m* W., $26^d\ 3^h\cdot1$ *m* S, $30^d\ 5^h\cdot7$ *m* E.: Japetus $5^d\ 1^h\cdot4$ *c* I., $24^d\ 9^h\cdot4$ *c* W.

URANUS is an evening star in Capricornus, 2° North of Moon on 1st.

NEPTUNE is a morning star, still too near the Sun for convenient observation.

COMETS.—See "Notes on Astronomy."

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant.		Remarks.
	R.A.	Dec.	
	°	°	
June-Sept. ...	335	+ 57	Swift.
July 25-Sept. 15	48	+ 43	Swift, streaks.
July-Sept. ...	335	− 73	Swift, short.
July-October...	355	− 72	Swift, short.
Aug.-Sept. ...	353	− 11	Rather slow.
Aug.-Sept. .	346	0	Slow.
Aug.-Oct. 2 .	74	+ 42	Swift, streaks,
Aug.-Sept. ...	63	+ 22	Swift, streaks.
Sept. 5-15 .	62	+ 35	Swift, streaks.
Sept. 6-17 .	106	+ 52	Swift, streaks.
Sept. 15-24 ...	14	+ 6	Slow.
Sept. 21	31	+ 10	Slow, trains.
Sept. 27-30 .	4	− 28	Slow.
Sept. 28-Oct. 9	320	− 40	Slow, small.

In the cases where the radiant is stated to be active for several months, there is a difference of opinion as to whether it can be regarded as a single shower or a combination of several.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable (see Table 41).

TABLE 40. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Time.	Angle from N. to E.	Time.	Angle from N. to E.
1914			h. m.	°	h. m.	°
Sept. 1 ..	17 Capricorni	5·8	8 34 *e*	54	9 52 *e*	253
,, 4 .	Wash. 1507	6·8	3 45 *m*	74	—	—
,, 9 .	BD + 16°·247	6·4	0 13 *m*	57	1 29 *m*	237
,, 10 ...	Wash. 176	6·7	—	—	2 50 *m*	233
,, 10 ...	16 Tauri	5·4	11 10 *e*	115	11 53 *e*	200
,, 10 ..	19 Tauri	4·3	11 19 *e*	79	0 23 *m* *	235
,, 10 ...	21 Tauri	5·8	11 41 *e*	74	0 48 *m* *	210
,, 10 ...	20 Tauri ..	4·1	11 42 *e*	119	0 23 *m* *	195
,, 10 ..	22 Tauri ...	6·5	11 44 *e*	83	0 50 *m* *	231
,, 11 ..	BD + 24°·562 . .	7·0	—	—	1 12 *m*	209
,, 12 ..	BD + 26°·731	7·0	—	—	0 44 *m*	289
,, 13 ..	BAC 1746 .	6·5	0 49 *m*	112	1 45 *m*	229
,, 13 ...	BD + 27°·1122	7·0	—	—	11 59 *e*	198
,, 14 ...	BD + 27°·1164 .. .	6·9	—	—	3 44 *m*	277
,, 17 ...	BAC 3209	6·3	3 10 *m*	80	4 1 *m*	318
,, 26 ..	Wash. 1220	6·8	7 58 *e*	77	—	—
,, 30 ..	BAC 7709..	7·0	6 39 *e*	110	—	—

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

The asterisk indicates the day following that given in the date column.

Attention is drawn to the occultation of the Pleiades on September 10–11.

TABLE 41. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
UW Pegasi	22 14	+2 ·3	8·5 to 9·7	185	Aug. 13.
δ Cephei	22 26	+58 ·0	3·6 to 4·3		
V Cassiopeiae.. ...	23 8	+59 ·2	7·1 to 12·6	229	Aug. 8.
TY Andromedae	23 11	+40 ·3	8·2 to 10·0	144	Aug. 3.
W Pegasi	23 15	+25 ·8	7·3 to 13·0	342·6	July 22.
SV Cassiopeiae	23 35	+51 ·8	7·5 to 9·2	272	Sept. 2
Z Aquarii ...	23 48	−16 ·3	7·3 to 9·5	216	Sept. 29.
R Cassiopeiae...	23 54	+50 ·9	4·8 to 13·2	431·6	Sept. 21.
W Ceti ...	23 58	−15 ·2	6·5 to 12·5	355	Aug. 20.

Minima of Algol $2^d\ 3^h\cdot 8\ m$, $5^d\ 0^h\cdot 6\ m$, $7^d\ 9^h\cdot 4\ c$, $10^d\ 6^h\cdot 2\ c$, $25^d\ 2^h\cdot 3\ m$, $27^d\ 11^h\cdot 1\ c$, $30^d\ 7^h\cdot 9\ c$. Period $2^d\ 20^h\ 48^m\cdot 9$.

Principal Minima of β Lyrae September $1^d\ 9^h\ c$, $14^d\ 7^h\ c$, $27^d\ 5^h\ c$. Period $12^d\ 21^h\ 47^m\cdot 5$.

CORRESPONDENCE.

SOME FRUITLESS EFFORTS TO SYNTHESISE LIFE.

To the Editors of "KNOWLEDGE."

SIRS,—The recent discussion on spontaneous generation, based largely upon Dr. Charlton Bastian's experiments, makes it difficult for me to hold my peace when it is borne in mind that I was in part, and to a very large extent, responsible for the revival of the subject in recent years.

Readers interested in the subject will find in *Nature*, May 28th, an interesting communication from Mr. B. A. Keen on the subject of cellular structures in emulsions. These formations, like Dr. Bastian's, are undoubtedly physical effects; but the peculiar striae, or layers, in a test-tube, in the nature of horizontal rings at regular distances down the tube, are of special interest and significance to the physicist, quite apart from the bearing which they may or may not have upon the question of cell structure in living matter.

A description of these, and the literature relating to them, has been given in my book on "The Origin of Life," with many cautions and precautions for the unwary. The continuity of nature can be maintained only by a reëditing of the biological dictionary, as Professor J. Arthur Thomson has pointed out.

Now I have been taken to task for publishing my results in the popular press; but this I venture to ask the hospitality of your coloumns to explain again, and in part to contradict. My results were published in the first instance in *Nature*. It was after that that I was interviewed by the *Daily Chronicle* and other papers, an honour not often accorded to a man of science. So invidious, indeed, did the course I had decided to take appear that certain dons of unspeakable nervousness were said to have got into hysterics like militant suffragettes, and their tarantic behaviour equalled only that of corybantic Christians of the Salvationist School; nor have they since ceased to hurl their boomerangs of unseemly epithets against me on every conceivable occasion.

The phenomena I have described are, I think, clearly physical effects, and not merely chemical, as has been suggested.

Let me emphasise, moreover, that I have done my best not to ignore or minimise the importance of the work of other observers working on similar lines, and that full credit is given in my book, and references given to their experiments and publications; for instance, those of M. Raphael Dubois. I do not know, however, how far his observations tally with my own, both in the details which I have given and in their relation to the ring formations, as also to the action of light.

It may be of particular interest just now to note that the aggregates formed by the action of radio-active salts on certain organic media disintegrate under the influence of light, just as Madame Victor Henri has found in the case of various bacilli.

These effects would most probably be produced also by the presence of radio-active bodies of a certain strength, instead of ultra-violet light, in both cases by the β and γ rays, and cause the subdivision of the nucleus when the radio-active substance is within it, without any external influence.

The formation of these rings, which are of the nature of layers approximately equidistant, in a test-tube containing the emulsion or colloid substance, is just what might be expected if the cells contained some slight radio-activity. This activity will subdivide the cells into innumerable particles, until a certain thickness of the medium in which they are immersed sufficed to cut off the radiation, when they would again begin to be formed under the influence through which they originally came together, until the process of disintegration once more exceeded that of aggregation, and the rings again broke up. A series of strata of cells would result recurrently down the test-tube, as I have described.

It seems necessary to emphasise once more in this perennial controversy that I have never claimed that these experiments afford direct first-hand evidence of spontaneous generation at the present day. They give rather, in my opinion, some suggestive analogies as to the manner in which cellular structures were first formed in protoplasmic substances without affording any explanation of the chemical synthesis of the latter.

It is the nuclear substance "germ plasm" that, still more than ordinary protoplasm, lies beyond our grasp; and it is the origin of the latter, and not that of protoplasmic cells, that constitutes the great enigma of life.

Throughout the whole range of the physical and biological sciences which it has been my endeavour to master for years past, I can find no trace of evidence or clue as to its nature and probable origin.

The phenomena of heredity and continuity of germ plasm indicate, no doubt, that these properties are ultra-atomic, and all that can be said at present is that the study of life leads us, not to molecules, atoms, and electrons, as many suppose, but that, through heredity, the phenomena of germ plasm inevitably carry us beyond them.

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NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

THE TOTAL NUMBER AND TOTAL LIGHT OF THE STARS.—I have more than once alluded in this column to the photographic map of the entire sky that was made by the late Mr. Franklin Adams. One of the objects that he had in view was to give more reliable figures than were previously available for the number of stars of each of the fainter magnitudes. When his health failed he handed over the plates to the Royal Observatory for the completion of this task. It was beyond the resources available to attempt to count all the stars on each plate, so a selection was made of certain small squares, symmetrically arranged over its area. The stars in these squares were counted, and the number on the whole plate estimated from the result. This work was undertaken by Messrs. Chapman and Melotte, and they have published their results in "Memoirs of the R.A.S.," Volume LX, Part IV.

One of the first requisites was to have a definite scale of magnitudes. The Harvard photographic sequence of stars near the North Pole was taken as the standard, its substantial accuracy being confirmed in many ways. In order to have standard stars, on the same scale of magnitude, distributed over the sky, numerous photographs were taken with the thirty-inch reflector at Greenwich. Duplicate exposures were made on each plate of the pole and of another region of the sky. Each exposure lasted about thirty-five minutes, which sufficed to show stars of the seventeenth magnitude. It was difficult to get sufficiently clear nights and to keep the focus of the mirror the same when the telescope was moved. Not more than thirty satisfactory plates were obtained in a year, but these sufficed for the purpose. Further plates are being taken at Helwan, Egypt, to carry the standard stars into the southern hemisphere.

One difficulty was the change in the character of the star images on the Franklin Adams plates, according to their distance from the centre: this appears to be fairly regular, and a table for the purpose was constructed.

The plates so far discussed do not completely cover even the northern hemisphere, but they are sufficiently well distributed, both in galactic longitude and latitude, to form reliable estimates of star-density. The stars are grouped in zones ten degrees wide according to their galactic latitude, north and south latitudes being combined. The zone at the galactic pole extends twenty degrees in latitude. I quote here the number of stars per square degree of and brighter than each separate magnitude, (A) in the galactic zone, and (B) in the galactic polar zone:—

Magnitude	5.	6.	7.	8.	9.	10	11.
A ...	·027	·102	·359	1·16	3·51	9·77	25·4
B ...	·013	·048	·158	·468	1·30	3·31	7·94
	12.	13.	14.	15.	16.	17.	
A ...	61·7	141	306	631	1245	2399	
B ...	18·0	38·5	77·6	155	295	556	

It will be seen that for the brighter stars A is twice B; for the fainter ones A is four times B. The numbers for the whole sky down to various limiting magnitudes are (in units of a million): To magnitude ten, a quarter; to magnitude eleven, two-thirds; to magnitude twelve, one and two-thirds; to magnitude thirteen, three and two-thirds; to magnitude fourteen, seven and a half; to magnitude fifteen, fifteen and a half; to magnitude sixteen, twenty-nine and a half; to magnitude seventeen, fifty-five; while the guesses by extrapolation for magnitudes eighteen and nineteen are ninety-one and one hundred and forty-four. The numbers are much smaller than those obtained by previous workers; thus the Bonn Durchmusterung contained one-third of a million stars down to nominal magnitude nine and a half in the northern hemisphere alone. It is probable that many of the stars labelled nine and a half would be given as ten, or fainter, or the modern photometric scale. There also seems to be a tendency for the photographic magnitudes of the faint stars to be fainter than the visual ones. The authors note that their figures clearly point to a diminution in the ratio of new stars that are added when the limiting magnitude is extended by one unit. On the assumption that there is no absorption of light in space this points to the limit of our star system being approached. They think that the number of stars in it would lie between one thousand one hundred and one thousand eight hundred millions, of which about half would be brighter than the twenty-fourth magnitude.

COMETS.—Delavan's interesting comet, which was discovered last December, but which will not pass perihelion till October 26th, has been hidden in the Sun's rays since April. It has now emerged, and is visible in the morning sky. It was first seen by Mr. W. H. Steavenson on July 4th at Mr. Worthington's observatory, Alton. It could be seen at an altitude of 1°, so that it was probably at least as bright as the sixth magnitude. He says: "It seemed fairly circular, condensed towards its centre, where there was a nucleus of about magnitude 7½. The diameter of the part seen was 5′; had the sky been darker faint outlying portions would doubtless have been seen." I think that the prospects are hopeful for this comet being an interesting spectacle in September and October. There is already no doubt that it will be visible to the naked eye. It will be in Lynx and Ursa Major in August and September, and will be best observed shortly before daybreak.

An ephemeris for August was given last month: it is continued here:—

		R.A. h m s	N.Dec. ° ′
Sept.	8	9 8 35	49 56
,,	16	10 8 6	49 51
,,	24	11 9 33	47 56
Oct.	2	12 7 1	44 9
,,	10	12 56 44	38 56
,,	18	13 37 56	32 57
,,	26	14 11 50	26 45
Nov.	3	14 40 44	20 40

Another very faint comet was found by M. Neujmin at Simeis, Crimea at the end of June: it passed perihelion at midnight on February 11th, omega being 289° 2′, node 265° 45′, i 36° 19′, perihelion distance 1·3545. It is rapidly fading, and will not be visible in small instruments.

THE SOLAR ECLIPSE OF AUGUST 21st.—Mr. A. Burnet, of Leeds, has kindly sent me some calculations he has made about the partial eclipse in England. Using corrected elements for the Moon from recent Greenwich observations, he finds for the beginning, greatest phase, and end of the eclipse at Greenwich the times 10h 58m 55s *m*, 0h 10m 49s *e*, 1h 20m 48s *e*. The beginning will be 63s earlier for each degree of latitude north of Greenwich, and 62s earlier for each degree of longitude west. The greatest phase will be 60s earlier for each degree of latitude north, and 80s earlier for each degree of longitude west. The end will be 58s earlier for each degree of latitude north, and 90s earlier for each degree of longitude west. The magnitude is ·021 greater for each degree of latitude north and ·011 less for each degree of longitude west. From these figures any observers within, say, one hundred miles of London will be able to predict the phenomena fairly accurately. Any observers who have the means of getting time to a second, by wireless telegraphy or otherwise, can do useful work by timing the first and last contacts. I recommend projecting the Sun's image through the telescope on to a screen in a darkened room, if this can be arranged. The approximate position of first contact must be known (see

the Face of the Sky for last month). Observers with spectroscopes can observe the first contact with greater accuracy by seeing the Moon projected on the chromosphere before it reaches the limb. True first contact is given by the instant when the dark Moon breaks the continuity of the lower chromosphere. It cannot be actually seen visually on the Sun till a second or two later than the geometrical contact. The method will also be available for the first contact in the transit of Mercury on November 7th.

The experience of Professor Newall in 1912 shows that it is possible to do useful work on the reversing layer in large partial eclipses. The points to be examined are those near the cusps.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

PLANKTON (FLAGELLATES AND GREEN ALGAE) OF THE ADRIATIC.—For some years systematic observations on the biology of the Adriatic Sea and neighbouring parts of the Mediterranean have been carried on by Austrian workers in the exploring ship "Najade." Schiller (*Sitzb. kais. Akad. Wiss. Wien*, Band 122) has published two papers on the most minute of the plankton forms, the so-called nannoplankton consisting of vegetable forms too small to be captured by means of nets, but obtainable from the water by the use of centrifugal apparatus and filters. It is becoming increasingly evident that the vegetable portion of the plankton—the small organisms which float freely suspended, especially in the upper waters—is of immense importance in the economy of the sea, and therefore to mankind. These plankton plants—Diatoms, Peridineae, Flagellata, and other minute organisms of more or less definitely vegetable nature (that is, capable of manufacturing organic food from inorganic materials by virtue of their chlorophyll or other light-absorbing pigment which enables them to fix carbon dioxide)—are either eaten directly by fishes or even by huge marine animals like whales, or form the food of smaller marine animals which in turn are eaten by fishes. Schiller's first paper deals with the Coccolithophoridae—the organisms of which portions of the limy covering were long ago known and described as "coccoliths"—of which he describes more than twenty new species. The whole of the Adriatic was explored for these minute organisms, samples being taken at ten-mile intervals, and in each case at thirteen different depths ranging from 0·9 metre to 1000 metres. The seasonal distribution of the minute Coccolithophoridae, which were obtained by the centrifuge method, was found to correspond in essential with that of the larger plankton forms (net-plankton), showing a minimum in winter (mid-November to mid-February); then a steady increase reaching a maximum in August and September, followed at the end of September by a rapid diminution. During the two years of the cruise this group was found to be represented in every part of the Adriatic, frequently in great abundance—as many as one million per litre of water. Various interesting points in the biology of this relatively little-known group of Flagellata were made out; for instance, the fact that six of the species can live in relatively fresh water containing less than 1·5 per cent. total salts. The inshore or littoral forms are more than twice as abundant as the pelagic or open-sea forms. As regards their vertical distribution the Coccolithophoridae are, like the Diatoms, essentially surface organisms, reaching their maximum either close to the surface at two to five or between two and twenty metres depth. This distribution is mainly conditioned by light intensity, since, despite the great fall in temperature observed in August, from about 23° C. in the surface water (0–10 metres) to about 16° C. at twenty metres many of the species occur abundantly in the lower depths; in August as many as four hundred and sixty individuals per litre were found at two hundred metres, as compared with sixteen thousand at the surface and over nineteen thousand at twenty metres. Below about twenty-five metres there is a rapid falling off in numbers; the result obtained by Lohmann off Syracuse—maximum at about fifty metres—is regarded by the author as an exceptional case attributable to purely local conditions, since the "Najade" observers found the greatest abundance of Coccolithophoridae in the Strait of Otranto in the upper twenty metres. The Adriatic results agree, however, in most respects, save the greater abundance, with those obtained by Lohmann for the Atlantic, the differences being attributed to the better methods and instruments used by the Austrian workers. Lohmann found that at Syracuse the maximum occurred in May the water containing about three thousand individuals per litre. The Austrian workers obtained in the not far distant Adriatic stations about fourteen thousand per litre in May and over nineteen thousand in August, the latter figure far exceeding that (seven thousand) given by Lohmann for the Atlantic. The waters of the Adriatic are therefore much richer in Coccolithophoridae than those of any other sea that has been investigated.

Finally the author emphasises the great importance of this group—which as he states is undoubtedly of vegetable nature, having yellow-brown or yellow-green chromatophores, with oil as assimilation product—as producers of organic substance. They occur in the alimentary canal of all plankton-devouring animals. The Salpas (free-swimming Tunicates) which in spring feed chiefly on Diatoms, rely largely upon the Coccolithophoridae and Peridineae after the Diatom maximum has passed, while Pteropods like the Cymbuliidae contain large quantities of these organisms throughout the year. From these observations it would appear that the Coccolithophoridae may play a much larger part in the nutrition of marine animals than has hitherto been attributed to them, the important point so far as the Adriatic is concerned being the fact that this group attains its maximum in summer at a time when there is a striking diminution in amount of the larger (net) phytoplankton forms.

(*To be continued.*)

CHEMISTRY.

By C. Ainsworth Mitchell, B.A. (Oxon), F.I.C.

SULPHUROUS AND SULPHURIC ACIDS AND VEGETATION.—An experimental investigation has been made by Messrs. Tatlock and Thomson (*Analyst*, 1914, XXXIX, 203) to ascertain the effect of sulphurous and sulphuric acids in the atmosphere upon the health of plants. The localities from which the plants were taken ranged from places where the air was exceptionally pure to districts where there was an atmosphere contaminated with gases and smoke. It was found that sulphurous acid became speedily oxidised to sulphuric acid in the plant, and the results were therefore calculated in terms of the latter (SO_3). The plants grown in a polluted atmosphere frequently showed three times or more the quantity of sulphuric acid found in the same plants grown in a fairly pure atmosphere. Thus grass usually contained a maximum of 0·3 per cent. of SO_3, but grown in a polluted atmosphere showed as much as 1·0 per cent. In spite of this difference, the grass was perfectly healthy, provided that free acid was not present.

This conclusion was borne out by many other results. For example, oak leaves from Langside (Glasgow) contained up to 0·42 per cent. of SO_3, but did not show any acidity, whereas oak leaves from another district contained only 0·202 per cent. of SO_3, but were acid and damaged.

Again, healthy neutral birch leaves from Langside contained 0·86 per cent. of SO_3, whereas acid and damaged leaves from a locally polluted spot contained only 0·248 per cent.

Observations made upon the air in the different districts

showed that it was only under exceptional circumstances that the atmosphere was acid, even in the case of cities burning large quantities of coal, the sulphuric acid derived from the coal being neutralised by ammonia from the same source, or by the bases in the floating dust in the air. When the air was found to be acid, as, for example, in the vicinity of acid fumes from chemical works, or from the burning of coal containing an excessive amount of sulphur (up to five or six per cent.), damage to vegetation was noted; but the effects were strictly local, and after the fumes had been dispersed into the surrounding air no acidity could be detected in the atmosphere, and plant life was apparently unaffected.

THE WATER OF DORTON.—In the village of Dorton, near Brill, in Buckinghamshire, there is a remarkable mineral spring which about the year 1830 was exploited as a spa, but has long since been abandoned. This spring had been known to the natives for many generations, and owing to its inky taste was commonly described as the "Alum Well." The ground for a radius of many feet was stained a deep yellowish-brown, from the deposition of iron oxide and sulphate, and from the astringent properties of the water the well had acquired a local reputation as a bath for mangy dogs and for "tanning" them for bull-baiting.

At the time when this spring was developed into a spa an analysis of the water was published by Professor Brande, and it is interesting to compare the results with the composition of the water at the present day. An analysis made last year by the present writer is published in the current issue of the *Analyst*, 1914, XXXIX, 210, and for convenience the figures obtained by Brande in 1830 are calculated upon the same basis of parts per one hundred thousand.

	Mitchell. 1913.	Brande. 1830.
Iron	45·6	32·0
Aluminium		3·52
Calcium	40·0	31·20
Magnesium	15·0	—
Sodium	8·5	6·29
Sulphuric Acid (SO_4)	243·0	202·89
Chlorine	10·0	9·71
	362·1	285·71

It will be seen that while the amounts of sodium, calcium, and chlorine have remained fairly constant, there has been a remarkable increase in the amount of iron sulphate. The water has a slight acid reäction, probably owing to the presence of free sulphuric acid, and this was also noted by Brande.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

THE PRODUCTION OF STEEL DIRECT FROM ORE.—In a paper read before the Iron and Steel Institute Messrs. Ernest Humbert and Axel Hethey give details of the smelting of Swedish and Brazilian iron ores to various grades of steel in an arc (Héroult) electric furnace. Melting was found to proceed quite normally, and reduction of the ore to follow normal chemical laws. There was much ebullition, owing to the large volume of oxides of carbon set free from the liquid bath. This is an essential difference from the reäction in modern blast furnaces, where spongy iron is first produced and then melted. The outstanding quality of the steels produced was their toughness, and this, the authors conclude from the nature of the process, is to be ascribed to the substantial absence of both nitrogen and hydrogen. Nitrogen, which is usually considered to have about five times the effect of phosphorus in producing brittleness and decrease of elongation, is added to steel by means of the air-blast in the case of blast-furnaces, converters, and cupolas, and in the case of open-hearth furnaces is probably added in the form of cyanogen and ammonium compounds by means of the flame. It is supposed to be present in the ferrite constituent of the steel as a nitride; it does not combine with the iron carbides. The effect of hydrogen in steel is also little understood, but the action is probably similar to that of nitrogen. The authors have come to the conclusion that with the aid of the modern electric furnace, and given satisfactory conditions, the economic manufacture of steel direct from ore is a practical possibility, and that the material produced will be superior to that manufactured by present methods.

A CURIOUS CASE OF DECARBURISATION DURING THE HARDENING OF STEEL DIES.—In some preliminary trials of an electric muffle for hardening steel dies the steel (containing about one per cent. of carbon and one per cent. of chromium) was allowed to soak at 820° C. for about one and a half hours, the working face of the die being protected against scaling by a sheet-iron cover filled with powdered charcoal. On removal from the furnace the cover was knocked off, the face brushed free from charcoal, and the block quenched under a spray. Curiously enough, the working face, which had been in contact with charcoal during the heating, was found to be soft to a depth of about half a millimetre, below which the steel was glass hard. Repeat tests showed that the effect of the charcoal covering was always to reduce the carbon content of the face to about 0·4 per cent. in one and a half hours. Some unprotected strips of similar steel heated alongside for comparison showed no loss of carbon at the face. Dr. H. C. Greenwood has communicated these observations to the Iron and Steel Institute with the object of ascertaining if similar effects have been observed by others.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

AN EXAMPLE OF RIVER-CAPTURE.—One of the most striking examples of the phenomenon of river-capture which these islands presents is seen in the headwaters of the rivers Spean and Spey in the south of Inverness-shire (see Figure 298). The feature is equally striking, whether examined by map or in the field. The general slope of the highlands of Scotland, as is well known, runs from north-west to south-east, and the consequent or primary river system follows that direction. The grain of the country is perpendicular to this line. A well-developed subsequent river system has grown up in that direction, and, on the whole, provides the dominant drainage system. Loch Laggan lies in a through subsequent valley whose floor is entirely below the thousand-foot contour. The river Spean provides an outlet to the loch. From the south-west end of the loch it flows in a course a little south of west to join the river Lochy, which empties into Loch Linnhe. The main stream feeding Loch Laggan is the river Pattack, which rises in the high land south of Beinn a Chlachair, and flows towards the north-north-west to within two miles of Loch Laggan. Its course then bends sharply to the south-west, and the river flows into the north-west end of the loch. Running parallel to the upper part of the Pattack, and about two miles to the east of it, is the Mashie Water, which rises in the hills west of Loch Ericht. When it reaches the through valley of Loch Laggan, this river turns north-east to join the Spey. Between the points where the Mashie and the Pattack bend the divide is remarkably low, and there can be little doubt that at one time the Spean flowed across it to form a tributary of the Spey. On the way it received as tributaries what are now the upper parts of the Pattack and the Mashie. An obsequent stream cutting back from the shores of Loch Linnhe must have captured the headwaters of the Spean, and brought about in time the reversal which now obtains. The tributaries of the Spean below Loch Laggan give strong support to this view. The map shows several of them coming in from the west, and

they approached in that direction so close to the main river that, judging by the map, one would say they flow in against its current. The river Roy shows similar features. It also has been brought to its present condition by the capture and reversal of streams at the head of the Spey.

While the Spean-Spey system is perhaps the most noticeable example of the phenomenon in the district, it is by no means the only striking one. The Truim-Ericht system may be mentioned, but maps of the adjoining parts may be studied with interest for numerous others.

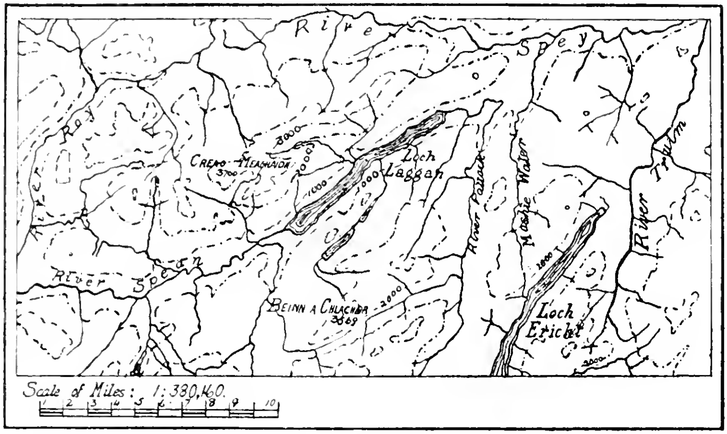


Figure 298. Sketch Map of Headwaters of Rivers Spean and Spey, with approximate contours at 1000 feet vertical interval.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

BALLSTONE.—An elaborate study of the peculiar lenticular structure known as ballstone, occurring in the Wenlock Linestone of Shropshire, has been made by Miss M. C. Crosfield and Miss M. S. Johnston (*Proceedings of the Geologists' Association*, XXV, 1914). The ballstones are unstratified, ovoid, or lenticular masses of limestone embedded in hard courses of stratified limestones. The bedding-planes of the latter generally stop abruptly where they abut against ballstone, but near the top of the lenticle they may curve over without discontinuity. The size of the ballstones varies greatly, but some reach a height of sixty to eighty feet. Both the ballstone and the adjacent stratified limestone contain a rich coral and stromatoporoid fauna; but in the former the fossils are mainly in the position of growth, and are enveloped by a flour-like calcareous matrix, whereas in the stratified limestones the fossils are largely in the condition of broken fragments.

The ballstones are considered to be the relics of large coral and stromatoporoid colonies still in the position of growth. They are identical in form and structure with the unstratified limestone masses which have been termed "reefs" by many authors. "The absence of coarse brecciated rock suggests that the colonies lived in comparatively calm or sheltered waters, whilst the fine, flour-like matrix in which the colonies are embedded is indicative of destructive wave-action at no very great distance, which has supplied the material, intercepted by the branching corals, and caught in the interspaces between the colonies. Such conditions are analogous to those now found behind a barrier reef or in a lagoon. That the colonies were originally of greater extent, but subsequently suffered destruction, is deduced from the presence of the large and identical coral fauna found scattered and overturned in the adjacent stratified beds." An instructive comparison is made with similar structures in the Palaeozoic limestones of Yorkshire, Belgium, and Gotland, the Tertiary bryozoan limestones of the Sea of Azov and the Black Sea, and in the Clinton and Niagara limestones of the United States.

The placoidal shape of the ballstones is ascribed to processes of contraction of the calcareous rock-flour during or shortly subsequent to the consolidation of the coral-rock and the death of the corals.

METEOROLOGY.

By William Marriott, F.R.Met.Soc.

THE THUNDERSTORM IN SOUTH LONDON, JUNE 14th.—Thunderstorms are supposed to occur during the summer months, so those which took place in many parts of the country during June were what might be ordinarily expected. The thunderstorm which passed over South London on Sunday, June 14th, was of a severe character, although not exceptional; but as several persons were killed by lightning while sheltering under trees on Wandsworth Common, more attention than usual was given to this storm. My observations at Dulwich may be taken as representative of what occurred in most of the area affected. Thunder was first heard a little before 12.30 p.m., and lightning was seen from about 12.45. These continued more or less throughout the afternoon until 5.0 o'clock, the lightning being very brilliant and rather frequent. Heavy rain fell from 12.50 until 1.10, and from 1.15 to about 2.20. Some white hail fell about 1.45 p.m., but at 2.0 there was a very heavy fall of big hailstones, as large as marbles, which lasted about five minutes. Many of these hailstones were like large acid tablets, about an inch long, half an inch broad, and more than a quarter of an inch thick. The hailstones were composed of perfectly clear ice, and did not contain any white opaque structure. Hailstones are usually accompanied by gusts or squalls of wind: in this storm, however, there was but little wind. When these big hailstones fell they tore the leaves off the trees, and so the pavements became quite green with the fallen leaves. The heavy rain quickly washed many of these away, so that they were carried into the gutters, and soon stopped up the drains, with the result that the roads were flooded. A minute or so after the big hailstones had fallen a mist arose above the road and pavement to a height of about four feet; this, however, gradually disappeared. Rain came on again about 3.15 p.m., and continued till 4.0. The total rainfall amounted to 2·15 inches, of which I believe about 1·60 to 1·75 inches must have fallen in three-quarters of an hour, from 1.30 to 2.15 p.m. Apparently there were four or five different thunderstorms.

COTTON AND WEATHER.—At the meeting of the Royal Meteorological Society on June 17th Mr. B. C. Wallis read a paper on "The Rainfall of the Southern Pennines." This enquiry had been undertaken with a view of attempting to find a scientific justification of the claim made for the wetness and humidity of Lancashire suitable to the manufacture of cotton. In summarising the distribution of the rainfall of the Pennine district, the author said it may be asserted that the west is wetter than the east on the whole

and as a rule, although the difference between the two areas is least marked during the dry season from March to May. In June and July, however, the lowland of the Trent and Ouse valleys received a relative excess of rainfall, which is compensated by the relative dryness in December and January. The uplands are absolutely wetter than the neighbouring lowlands, and the western slopes are wetter than the eastern slopes, but the difference in rainfall between upland and lowland is least marked during the warm weather and most marked during the cold weather. Throughout the whole district, on the average, the rainfall decreases in intensity from January until April, increases from April to August, shows a drop in relative quantity for September, rises to a maximum in October, and then declines until December. The south-westerly and westerly winds bring a steady rainfall, which is almost the sole rainfall during the winter months. The dry season occurs when the air temperatures are decreasing—when the British Isles are, as it were, in a tepid, not a hot bath. The months of maximum rainfall are months when the air temperature is decreasing, and when the variant winds from north, east, and south, in turn or together, bring more rain than during other seasons, so that the surplus rainfall of these months may be regarded as due to the other winds than those from the west and south-west. Mr. Wallis is of opinion that the local relief of the Pennine Uplift gives to the cotton towns their characteristic climate, and is the dominant factor which has made Lancashire supreme in the cotton industry.

MICROSCOPY.

By F.R.M.S.

THE QUEKETT MICROSCOPICAL CLUB.—The five hundredth ordinary meeting of this well-known club took place on June 23rd, 1914, when, in the unavoidable absence of its President, the chair was occupied by Dr. E. J. Spitta, M.R.C.S., a Vice-President, and the President for four years, 1904 to 1907, who, in the course of a humorous speech, gave a brief summary of the history of the Society. It appears to have been originally suggested by a letter from Mr. W. Gibson, published in *Science Gossip* in May, 1865, in the course of which he expressed the opinion that a Society on similar lines to that of the established Society of Amateur Botanists was very desirable for amateur microscopists, and he therein outlined the basis upon which he thought it could be established. The idea was at once taken up by the then Editor, who invited correspondence on the subject from those persons desiring to join together for the purpose, and having consulted with his friends W. M. Bywater and Thomas Ketteringham a meeting of twelve gentlemen interested in the subject was called for June 14th, 1865, at the office of Mr. Robert Hardwicke in Piccadilly. Eleven of those summoned attended this meeting, and with Mr. M. C. Cooke in the chair decided, on the motion of Mr. Gibson, that a Society of the kind indicated was desirable. On the proposal of Mr. Edward Jaques, a provisional committee of five was appointed to consider the matter further. Mr. Bywater was nominated as Secretary, and the meeting was adjourned to July 7th at St. Martin's Schools, when about sixty gentlemen attended. It was then determined that the Club should be named after the late Professor Quekett, whose lamented death had occurred in 1861, and other recommendations of the provisional committee as to the dates of future meetings, the subscription to be paid by members, and the mode of conducting the business of the Club were discussed and passed, the meeting being adjourned to August 4th. This was also held at St. Martin's Schools, when eleven by-laws were duly passed and officers for the ensuing year were elected, Dr. Edwin Lankester being the first President, Mr. Bywater the Secretary, with Mr. Robert Hardwicke as Treasurer. The first ordinary meeting was held at the room in 32, Sackville Street, when the President delivered the inaugural address, and some of the newly elected members brought their microscopes and exhibited objects of interest. The Club continued to meet in Sackville Street until February, 1866, when, from the increase in the number of members, the room there became obviously too small, and permission was obtained for further meetings to be held in the Library of University College. From this small beginning the membership has increased to about four hundred and fifty, an extensive library has been formed, a cabinet of slides has been established, fortnightly excursions to promising localities in the neighbourhood of London have been arranged, and occasional dinners and soirées have been organised. Since its commencement in 1865 there have been twenty-two Presidents, holding office for from one to four years, of whom twelve are now deceased, and seven Secretaries. Of those members who were elected during the first year only seven now remain on the list, and of these two alone continue to attend the meetings, but the veteran Dr. M. C. Cooke, now in his eighty-ninth year, by a congratulatory letter sent to the last meeting still shows his unabated interest in the welfare of the Quekett Microscopical Club.

R. T. L.

II.—THE COMMON GNAT.—The life-history of the Gnat (*Culex pipiens*) is very simple, and is begun in the pools, ditches, and water which we have around our homes, especially in the country.

Still water, containing an abundance of decaying leaves and multitudinous forms of microscopic life, provides the most suitable breeding place for the insect.

The larva (see Figure 299) will be found in abundance near the edges of the water, hanging head downwards, with its tail end communicating with the air, wriggling about when disturbed, and sinking to the bottom at the slightest vibration.

It appears to be black in colour, and its length averages between half an inch to about three-quarters when fully grown.

The head of the larva is furnished with a large number of long and short hairs, mainly used for sweeping into its mouth the various animalculae within reach, upon which it feeds. On each side of the head are two prominent, tube-like outgrowths, which appear hollow, closed at the tip with a number of stiff hairs: these tubes later function as breathing organs in the pupal stage, but in the larva they are closed.

The large compound eyes, bulging out at each side of the head, are particularly noticeable, and these later become the or.ans of sight for the winged insect. The larva has no limbs, but its body is divided up into segments, eight in number, the last segment being specially developed for breathing, known as the *cylindrical respiratory syphon* (see Figure 300).

This syphon is traversed by two large air-tubes, which can be seen to pass backwards into the body and continue throughout its length to the head, thus all parts are supplied freely with air.

We now have the reason why the gnat larva, when at rest, suspends itself head downwards, so that the breathing tip of the tail is placed on the surface film of the water, and at the same time it can also feed.

By examining a mounted specimen in which the body of the larva has been made transparent, we can study the internal organs.

The alimentary canal commences with a long, narrow oesophagus, and this leads into the crop, or gizzard; behind we have the stomach, seen as a dark line extending about halfway through the body. The stomach leads into the intestine, and the Malpighian tubules open into the latter, acting as excretory organs.

The dark colouring of the stomach is due to the undigested particles of food, with earthy particles adhering to them, and digestion is carried out by the food previously masticated being passed slowly along and partially absorbed. The insoluble matter is then transferred to the intestine.

The breathing of the larva is effected by means of the spiracles situated at the end of the respiratory tube: these

spiracles are guarded by three pointed flaps forming a valve, and, when closed, pierce the surface film of the water; when opened they form a cup-like depression in the surface film, from which the larva hangs.

Once a supply of air has been accumulated, the larva sets itself free from the surface film of the water and dives down, having previously closed its tracheal tube by means of the valve.*

It is interesting to know that the larva is slightly heavier than water; if it were lighter, then it is obvious the peculiar upside-down position would be impossible, for the body would then have to lie flat on the surface of the water. This is proved easily by disturbing the larvae when breathing, for they at once slowly sink to the bottom of the pool; but, after a very shot period, the journey upwards is commenced, and this is carried out by a series of jerking movements of the body, produced by the lashing of the tail appendages. Once the surface is reached, the larvae again suspend themselves upside down, remaining quite still, as found before being disturbed, the breathing process being continued. The explanation why it is possible for a body heavier than water to remain in the position in which Gnat larvae are found is rather interesting, and was solved by the joint experiments of Professors Miall and Stroud, under whom the writer studied at Leeds University.

The whole solution of this problem resulted in the explanation that the larva maintains itself at the surface of the water by taking advantage of the surface film, which overspreads the surfaces of all free liquids—*e.g.*, a steel needle floats on water for the same reason—and the Gnat larva is supported by the pull of the surface film on the pointed valves which open and close the air-tubes.†

The larva of the Gnat during this stage moults its skin for about three or four months, and then becomes ready for pupation form, and, further, by this time the parts necessary for the winged fly are in an advanced stage of development.

When the moult of the last larval skin has taken place, the new parts begin to assume their proper form and position, and in almost a few seconds the shape of the larva is at once changed into a pupa. The pupa is totally different from the larva both in size and habits, and really contains the fully formed fly, closely packed in a tight-fitting transparent skin, in which the winged form is kept a prisoner for a few days.

The pupa (see Figure 301) in shape resembles a comma, and, when found floating, the two ends are bent on themselves, with each point directed downwards. Its buoyancy is remarkable, owing to the internal parts being filled with large supplies of air, and when at rest it takes advantage of the surface film of the water, as in the case of the larva, only sinking when disturbed. The swollen head encloses the wings and legs of the fully formed fly, with compound eyes, mouth parts, antennae, etc.; each part has its own separate covering. The tail end is furnished with thin, flat hairy structures, and this enables the pupa to swim, controlling its direction. The position of the respiratory tubes has changed from the tail in the larval form, and now they are found on the head, one on each side, standing out like horns, or trumpets, thinner at their point of attachment than at the top.

These "air-trumpets" are placed in a position so that the broad ends can be embedded in the surface film of the water, and water is kept out by an arrangement of multitudinous hairs, which project from the inner walls of each trumpet. Air taken in by means of these trumpets is passed forward into the tracheal system, or air-tubes, of the body, and thus the latter is well supplied with air, which can be passed through all parts of the developing insect.

It is only natural that one would ask why the position of the respiratory intake has been changed from the tail of the larva to that of the head in the pupa, and this is easily understood when we find that the pupal form does not feed, and, further, that the emergence of the fully formed fly is effected by the splitting open of the swollen-head structure.

The winged insect, whilst it is enclosed in the head of the pupa, needs large supplies of air, and, consequently, the best position for the air-trumpets is in this region, which communicates direct with the supplies of air taken in.

The pupal stage lasts about three days in the summer, and when the skin ruptures along the thoracic region (on the back), and the Gnat begins to emerge gradually by drawing out its head, abdomen, wings, and legs, this process is performed by the body bending backwards till the whole insect has appeared (see Figure 303).

The time taken for this process is very short, and it requires a very quick eye to witness all the various movements as they take place, for no sooner has the Gnat fully emerged than a resting period of a few moments is taken by floating on the empty pupal skin until the wings dry, and then the insect sets off on its new existence (see Figure 305).

As in all other forms of insect life, we have in the Gnat two distinct sexes, male and female (♂ and ♀), and these distinctions are very marked, as will be seen later. The Gnat (♀) has its mouth parts specially constructed for sucking purposes, and, with the lancets, can pierce the skins of animals, drawing blood from the region attacked.

The parts performing this function (see Figure 302) consist of a long tube covered with hairs, and at the base are two lips, or lobes, which cover the hole in the skin of its victim in such a way that air cannot enter the tube when blood is being drawn from the wound.

Running alongside this tube, or *labium*, as it is better termed, we have the piercing organs, the ends of which are jagged like a saw: these piercers are the mandibles and maxillae, specially adapted, this explaining why they differ so much from the identical parts found in other insects.

The Gnat, when about to bite its victim, first plunges into the skin its mandibles and maxillae, making a round puncture. The labium is then applied to the hole made, and as the blood is drawn up through the labium the piercers are plunged further in to produce deeper penetration, and cover a larger area, from which more blood can be gathered into the labium.

As the process of sucking blood goes on, the head of the Gnat sinks lower and lower, till it almost touches the skin of its victim, and the labium becomes bent on itself, whilst the piercers are almost buried in the wound made. The body of the insect swells visibly as it becomes gorged with the blood of its victim, and it is well known that the female Gnat is a glutton for blood, especially the blood of human beings.

The reason why the female Gnat is so fond of blood is very difficult to explain, and certain theories have been advanced. One theory assumes that a supply of highly nutritive fluid is necessary for the sustenance of the insect previous to the laying of its eggs.‡

The sucking process is effected by the oesophagus becoming dilated, and this part acts as a sucking machine, for in front of the gullet is a minute valve which prevents the blood drawn up from escaping again through the labium. The enlargement of the oesophagus causes the internal pressure to become reduced, and the blood flows upward through the labium as seen in a syphon tube.

The antennae of the female Gnat (see Figure 306) are found one on each side of the head, springing directly from beneath the large compound eyes, and in structural detail differ very much from those present in the male.

They appear as jointed or stalked processes, having at each joint or node several stiff hairs, pointed at their extremities, and resemble very much the stem of a plant, especially the Horse-tails (*Equiseteum arvense*).

* "Life-Story of Insects," Carpenter, page 77.

† "Natural History of Aquatic Insects," Miall, pages 99-103; "Injurious and Useful Insects," Miall, page 126.

‡ "Natural History of Aquatic Insects," Miall, page 109.

FIGURE 299.

Larva of the Gnat (*Culex pipiens*).

FIGURE 300.

Breathing Tube of the Gnat larva, situated at the tail-end.

FIGURE 301.

Pupa of the Gnat.

FIGURE 302.

Head of the Gnat ♀, showing the labium, labial palps, mandibles, maxillae, and antennae.

FIGURE 304.

Head of the Gnat ♂, showing labium, nasal ..., fused mandibles. The labial palps are absent.

FIGURE 303.

Winged insect emerging from the pupal skin halfway through the process of bending backwards.

FIGURE 305.

Female Gnat after emergence from the pupal skin.

FIGURE 306.

Antennae of a Gnat ♀, showing the distal joint and the very few hairs.

FIGURE 307.

Part of a Gnat's wing, showing the "nerves" and hairs upon it.

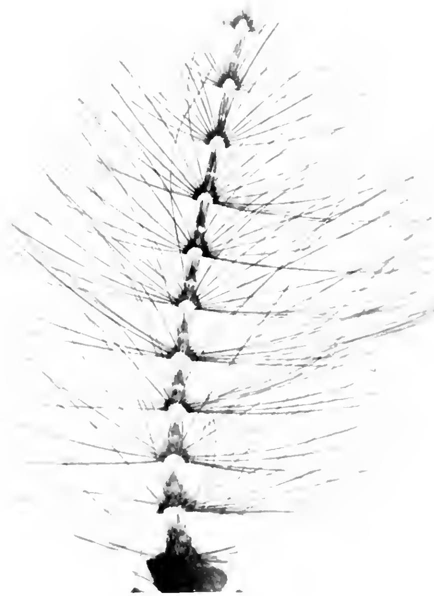


FIGURE 308.

Antennae of the Gnat ♂, showing many of the joints and long projecting hairs.

The mouth parts of the ♂ Gnat (see Figure 304) are not as elaborately formed as those found in the ♀, and, in consequence, it is generally believed that the ♂ cannot bite in the same way, or draw up blood from animals; the mouth parts are very simple in structure.

If this is true (the question of the male being a vexed one), then no doubt its food is obtained in another way than by using its mouth parts. The mandibles and maxillae are fused into one piece; even the labium differs; and its sucking machine, the oesophagus, is undeveloped. It is a well-known fact that the female Gnats outnumber the males, and the latter are somewhat difficult to collect or even find. Perhaps this may be due to the district,* but information of this kind would be valuable for records.

The antennae of the male Gnat provide the main distinction between the sexes beyond that of biting, and the organs which are used for this purpose. In structure they are jointed as in the ♀, but the joints are shorter, and are fitted together in a different way (see Figure 308). At each node or joint are an enormous number of fine projecting hairs of much greater length than those found in the ♀, giving the antennae a bushy appearance, which can be readily detected by the naked eye. The large compound eyes are situated one on each side of the head, and bulge out prominently. They are made up of a large number of circular facets, hexagonal in shape, and it has been proved that those of the ♂ are considerably larger than the eyes of the ♀. This is generally the case in all male insects, and forms another link to the theory of evolution, the eyes of the male being constantly on the look-out for the female insect for pairing, and no doubt considerable distances have to be traversed for this purpose. It might be mentioned here that in exceptions the eyes of some insects are exactly the same size in both ♂ and ♀, but the ♂ insect has a larger number of facets developed.†

The ocelli, or simple eyes, found in insects and spiders generally, are absent through abortion in the case of the Gnat; further, the chitinous structure is very transparent, the pubescence is also bare, and the plates bend round the antennae.‡

The wings of both sexes are very similar, and appear as a marvellous revelation of beauty and structure for such a small insect, even when examined under a low magnification (see Figure 307).

On the outer portions of the edge nearest the body of the insect are innumerable short hairs, arranged in clusters, forming a heavy fringe, which commence from the tip of the wing, and are present only on this inner edge.

The veins or nervures of the wing are also covered with short thick hairs and scales, in form being broad on the top and pointed at the base, where they are attached in regular rows on each nerve or veinlet. These scales, it is interesting to note, resemble very closely those found on the wings of the various species of Lepidoptera, but they are of a much smaller size when comparisons are made.

W. Harold S. Cheavin, F.R.M.S.

(To be continued.)

PHOTOGRAPHY.

By Edgar Senior.

PHOTO-MICROGRAPHY. ILLUMINATION OF OPAQUE OBJECTS UNDER LOW-POWER OBJECTIVES.—In our notes in the June issue of "Knowledge" we dealt with lower-power photo-micrography of objects that had not been specially prepared for the microscope, and we now give an example of this kind of work photographed with a Zeiss 100-millimetre planar, the object being a piece of American red gum wood split off from a block, and simply attached to a glass slip with plasticine. Obviously, as the specimen is opaque, it must be illuminated by reflected light, and there are a number of ways by which this may be easily accomplished and at the same time even illumination obtained over the entire surface. As this example was taken in illustrating to a class the various methods available for lighting objects of this nature, we cannot do better than repeat them. In the first place, as a considerable distance (4¼ inches) intervened between the objective and the object, there was plenty of room for any illuminating apparatus to be placed between them, and it was shown that by placing an optically worked disc of glass in such a position that it formed an angle of forty-five degrees with the axis of the lens that light reflected on to this disc by means of a plane mirror formed a means of illuminating the object perfectly, and that the reflected light transmitted by the objective enabled an image to be focused upon the screen that was both clearly defined and evenly lit. In employing this method, however, a strong illuminant is necessary, since the quantity of light that is reflected from glass only amounts to about four per cent. of that which falls upon it, so that in many cases the exposure required would be excessively long. This method of lighting has the advantage, however, that, owing to the light impinging on the object vertically, the structural detail will appear much finer in an object such as that shown in the photograph than it would do were the light to strike it more or less obliquely. When it is desired to obtain very strong illumination, then the transparent reflector is removed, and the plane mirror employed alone being placed at such an angle that the light is directly reflected from its surface on to that of the object, when, under these conditions, the image of the latter projected upon the screen will be found to be very bright, but at the same time much coarser in appearance, owing to the contrast produced by this method of lighting with objects having alternately raised and hollow surfaces. The appearance of the image, however, may be modified by rotating the stage upon which the specimen rests, as in this way the shadows will be modified according to the direction in which the light strikes the raised portions of the object. In the illustration (see Figure 293 on page 299) the lighting was further modified by using the plane side of a reflector attached to the body of the microscope to reflect the light on to the object, as this could be brought closer to the latter, the small mirror receiving its light from that reflected from the large plane one. By this method and careful adjustment of the apparatus generally, an image which was finer, and, at the same time well illuminated, was obtained. The photograph which is shown as an example was then taken, using an Imperial N.F. plate and a green light filter, the exposure given being five seconds, the lens having been stopped down to F/32, in order to obtain the necessary depth of definition. The dark portions, containing the gum, are well defined against the lighter parts of the woody fibre, and the result is an excellent example of what may be obtained by the method of illumination employed. When greater magnification is desired, and it becomes necessary to employ shorter focus lenses, then the object may be illuminated by means of a converging beam of light from a bull's-eye condenser, the illuminant being placed in front of the microscope stage, care being taken that the light shall impinge on the object as nearly as possible in a vertical direction, in order to obviate as much as possible the production of excessive shadows. In some cases, it may even be necessary to place a lamp and condenser on each side of the object in order to obtain the necessary freedom from heavy shadows. It must, however, not be forgotten that in many cases these shadows form the chief means of imparting the appearance of relief to the photograph, and so must not be entirely eliminated. When the distance between the various object planes is considerable, it will be found necessary to place

* The writer speaks of the North Country—Yorkshire, W.R.

† The Structure of the Eye Surface and Sexual Differences, *J.Q.M.C.*, Volume X, page 367.

‡ *Ibid.* Eye of Water-beetle, "Knowledge," Vol XXXVII, page 225

a stop above the objective in order to increase its depth of definition, " or a piece of apparatus known as a Davis Shutter may be employed for the purpose." In photographing opaque objects the presence of a cover glass often gives rise to reflections which cause a great deal of trouble, and in many cases it is necessary to remove them before a satisfactory photograph can be obtained. Besides the methods already described for illuminating opaque objects, there are others which may be used that are found useful at times, such as that obtained by means of a parabolic silvered side reflector, or a piece of apparatus known as a "lieberkuhn." Their use, in many cases, however, is in no way superior to those previously explained.

DIAMOND JUBILEE OF *THE BRITISH JOURNAL OF PHOTOGRAPHY.*—With the issue of June 19th *The British Journal of Photography* celebrated its sixtieth year of continuous publication, and, in order to mark the event, presented to its readers a supplement containing a review of the progress of photography from the year 1839 to the present day, together with portraits of past and present editors of the journal, and also of early workers in the art, to whose labours the position now occupied by photography is largely due. The great developments which have taken place in photographic processes since the time when the action of light was first employed as a means for recording the forms of objects have in many cases been the result of contributions made to *The British Journal* by workers in the past, many of whom are no longer with us; and we often feel that the photographer of to-day scarcely realises the great debt which he owes to these early experimentalists for the generous spirit with which they made their discoveries known. The observations made with regard to the effects of light, even before photography was thought of, were very considerable; and to attempt to give even a brief record of the chief discoveries in photography from the earliest times would fill a volume of considerable size; while the work of such men as Eder, Abney, and Vogel would in itself be more than sufficient for any ordinary one. Then, apart from photography pure and simple, there are its many applications, chief among which are its use in the reproduction of colours in objects, photo-mechanical processes, and kinematography; and although a great deal of the experimental work that is being done in the applied science of photography is due to those who belong to countries other than our own, we are kept in touch with it through the medium of the photographic press, and, in particular, by *The British Journal of Photography*, which has always devoted itself to the interests of the professional photographer. And while we heartily congratulate the proprietors and editors on the attainment of the Diamond Jubilee of their paper, we trust that it may still continue in the same course of usefulness and interest that has marked its career in the past.

PHYSICS.

By J. H. Vincent, M.A., D.Sc., A.R.C.Sc.

DEATH OF MR. THOMAS THORP.—It is with great sorrow that we learn from *Nature* of the death of Mr. Thomas Thorp, who originated the process of taking celluloid casts of ruled diffraction gratings. It is now fourteen or fifteen years since Thorp replicas began to be well known. They are now common in all laboratories over the world, and have proved a great boon to the amateur physicist. Before Mr. Thorp introduced his copies the only cheap diffraction gratings were produced by photography. These, however, usually on bichromated gelatine, were difficult to make, and the new process soon displaced the older methods of reproduction. It could be applied to the finest rulings, and gratings of high dispersion were thus rendered available where the cost of the originals made their purchase impossible. Mr. Thorp's inventive genius was active in several fields. He designed the first prepayment gas meter, discovered a method of protecting silvered telescope mirrors by a thin layer of varnish, and applied his gratings to colour photography.

UNIVERSITY APPOINTMENT.—Dr. Niels Bohr has been appointed Reader in Mathematical Physics in the University of Manchester. This brilliant young mathematical physicist leapt into fame by the publication of a series of remarkable papers on the constitution of atoms and molecules in the *Philosophical Magazine* last year. The fundamental idea of these papers is the mathematical treatment of a theoretical atom invented by Professor Rutherford to explain the results of experiments on the scattering of the α-rays by matter. These α-rays have been proved to consist of a flight of very rapidly moving material particles. Each particle is an atom of the rare gas helium, and differs from an ordinary atom of helium in that it is charged with two elementary units of positive electricity. When the α-rays, emitted by radio-active substances, are allowed to traverse matter, they suffer a scattering which, when studied quantitatively, suggested to Professor Rutherford that the atom must consist of a massive particle of very small size, with a positive electric charge round which revolve in orbital motion a number of electrons, or disembodied negative charges, of such a number as to make the total electric charge on the whole atom zero. The difficulty about this atom of Professor Rutherford was that the orthodox methods of mathematical analysis were incapable of dealing satisfactorily with the problems involved. Dr. Bohr got over this difficulty by using ideas imported from Planck's theory of radiation, according to which energy is itself regarded as consisting of indivisible quantities. The result was that he could calculate the size of atoms, explain the series of lines found in the spectra of some of the elements, and give a mathematical theory of the constitution of molecules.

THE ELECTRICAL RESISTANCE OF METALS AT LOW TEMPERATURES.—It has long been known that the resistance to the passage of the electrical current offered by a metal wire depends on the temperature. In the case of alloys the resistance may either decrease, increase, or remain stationary, when the temperature rises, according to the constituents of the alloy; but with the pure metals the laws of change of resistance with temperature are much simpler. In all cases the resistance falls when the metal is cooled. An extensive series of experiments on the resistance of pure metals between temperatures $-200°$ C. and $+200°$ C. was performed in 1892 and 1893 by Fleming and Dewar. The lowest fixed temperature employed was that of the boiling point of liquefied oxygen ($-182°·5$ C.). From their results a chart was drawn showing the resistivity plotted as a function of the temperature for each metal. If the horizontal base line be marked out with temperature increasing to the right with the resistivity increasing upwards the general result of Fleming and Dewar's research may be stated as follows: The lines for all the metals are nearly straight, some being slightly convex, others slightly concave: they all slope downwards from right to left, so as to give the appearance that they would, if continued far enough, meet roughly at the temperature of absolute zero ($-273°$ C.) on the line of no resistivity. It seems, however, evident from Fleming and Dewar's curves that the lines do not converge to precisely the same point. The exact shape of the curves towards the lower ends is a matter of very great interest, and has been the subject of research in the renowned cryoscopic laboratory at Leyden by Professor Kamerlingh Onnes for some years. In 1911 he published some results of determinations of the resistance of Pt, Ag, Au, and Pb at the low temperatures attainable with liquid helium, and shortly afterwards began to study Hg. It was found that a mercury resistance which measured 172·7 ohms at 0° C. measured only ·084 ohm at 4°·3 absolute, while at 3° absolute it was less than three millionths of an ohm. It thus appeared that, contrary to what had been expected, the resistivity curve dropped suddenly down on to the line of no resistance before the

metal had been cooled to absolute zero. Subsequently (1913) it was found that this collapse in the resistance occurred within a fall of temperature of about ·02 degree beginning at 4·21 absolute. When the temperature was lowered to 2·45 absolute the resistance was less than a twenty thousand millionth of that at 0° C., while with a potential difference of ·56 microvolt on the ends of the mercury thread the current density was over a thousand amperes per square millimetre. It was also found that similar results occurred at these low temperatures in the case of tin. On June 29th, 1914, Professor Onnes communicated to the French Academy some further results, in which the effects are found in lead, and in which experiments of a very striking character are recorded. The almost total loss of resistance occurs in the case of lead at a slightly higher temperature then in the case of the metals previously investigated. Thus a coil of pure lead which had a resistance of seven hundred and thirty-six ohms at ordinary temperatures became practically resistance-less at the temperature of liquid helium, so that a current of electricity set circulating in it by induction continued to flow for some hours sensibly undiminished in strength. The lay press has been aroused to an interest in the subject by these experiments. It is quite possible that one of the results of these researches will be to supply a method of obtaining very intense magnetic fields. The limits imposed by resistance are the chief difficulties met with in designing apparatus such as powerful electro-magnets. Professor Perrin proposed some time ago to use coils placed in liquid air for obtaining high magnetic fields. Even here, however, the power required turns out to be very high. If, however, the coils could be robbed of their resistance by liquid helium, it looks as if the attainment of magnetic fields of immense strength would be rendered feasible.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A., LL.D.

RESPIRATION IN WATER-BEETLES.—It is usually stated that insects drive the air out of their tracheae by the contraction of expiratory muscles situated in the abdomen, and that inspiration is passive. Frank Brocher has convinced himself that this statement is not always true. In Water-beetles of the well-known genera *Hydrophilus* and *Dytiscus* the chief respiratory movements are localised in the metathorax, not in the abdomen. In *Hydrophilus* inspiration appears to be as active as expiration, and the muscles concerned in the inspiration are the stronger.

TERNS PLUNGING BELOW THE SURFACE.—Most observers are agreed that Terns usually pick up their food from the surface of the water, but Mr. W. Bickerton records seeing "the underwater plunge" on the part of the Sandwich Tern, the Common Tern, the Arctic Tern, and the Lesser Tern. The Lesser Tern, closely followed by the Arctic Tern, is most addicted to plunging. Mr. Bickerton's observation is confirmed by Messrs. Headley and Oldham as regards the Common Tern. It is not asserted, however, that feeding from the surface of the water is not the rule. The point is one of considerable importance in connection with the case brought against Terns as destroyers of fry.

WEIGHT-LIFTING POWER OF WASPS.—In enlarging the underground nests, which some kinds of social Wasps make, it is often necessary to make excavations, and obstacles met with must be removed or allowed to accumulate on the floor of the cavity. Mr. Charles Oldham has watched Wasps (*Vespa germanica*) removing pieces of chalk and flint, and flying off with them in their mandibles. A talus of fragments was observed near the nest, and the average weight (·347 gramme) was more than 4·5 times the average weight of the Wasps (·076 gramme). The insects always tried to fly, but the flight was sometimes very short and laboured. Similar observations were made in regard to *V. vulgaris*: it was found that individuals of this species carried fragments of stone nearly four times their own weight. Even if a Wasp plies its wings at the rate of one hundred and ten beats per second, its ability to carry stones about four times its own weight is very remarkable, and, as the observer points out, is far more than any bird can do.

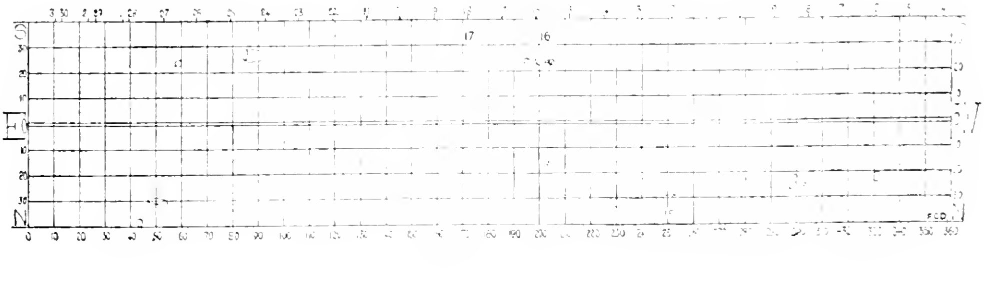
SOLAR DISTURBANCES DURING JUNE, 1914.

By FRANK C. DENNETT.

The Sun was under observation every day during the month, but only on three occasions (2nd, 23rd, and 28th) appeared quite free from disturbance, but on twelve others (1st, 3rd to 7th, 24th to 27th, 29th, and 30th) only faculae were visible. Spots were seen on the remaining fifteen days. The longitude of the Central Meridian at noon on June 1st was 36° 53′.

No. 15.—On the 7th a faculic disturbance was seen well round the north-eastern limb extending from latitude 26° to 34°, brightest in the equatorial half. On the 8th it contained two larger and two smaller pores. During its visibility the leader increased to seven thousand miles in diameter, and the group attained a length of forty-nine thousand miles. It was largest on the 10th, and then dwindled until last seen as minute pores on the 15th, the area remaining faculic until the limb was reached on the 18th.

DAY OF JUNE, 1914.



No. 16.—On the 12th a triangle of three pores had developed in the south-eastern quadrant. The group lengthened to seventy-seven thousand miles. The western spot was twelve thousand miles across on the 15h. The maximum area of its members was reached on the 18th, when the trailer had reached a diameter of twenty-two thousand miles, whilst the leader had penumbral extensions to quite twenty-seven thousand miles. It was last seen on the 22nd, when there was a big spot reduced to a narrow line close within the limb, and followed by faculae.

No. 17.—A faculic area seen a little north-east of No. 16 on the 12th. Next day a pair of pores showed. On the 13th there were six pores visible. On the 14th a spotlet with two tiny pores to the west. The spotlet alone remained on the 15th and 16th. On the 17th there were two minute pores, and on the 18th two differently placed, but not seen after. The faculic remains were visible on the 22nd.

Faculae were recorded near the western limb on the 3rd and 14th. Near the north-western limb on the 5th and 6th (longitude 54°, N. latitude 30°), 24th and 27th. Near the north-eastern limb on 1st, 3rd, 4th (longitude 300°, N. latitude 26°), 10th and 11th (longitude 202°, N. latitude 16°), 13th and 24th (longitude 43°, N. latitude 38°), 25th and 27th (longitude 331°, N. latitude 22°). Near the eastern limb on the 3rd and 4th (longitude 297°, S. latitude 10°). Near the south-western limb on the 4th and 5th (longitude 59°, S. latitude 23°), 10th, 11th, 26th, 29th, and 30th (longitude 86°, S. latitude 28°). Within the south-eastern limb on the 10th and 12th. And also near the North Pole on the 27th.

Our Chart is constructed from the combined observations of Messrs. John McHarg, J. C. Simpson, W. H. Izzard, E. E. Peacock, and the writer.

REVIEWS.

ASTRONOMY.

An Introduction to Celestial Mechanics.—By Forest Ray Moulton, Ph.D. Second revised edition. 437 pages. 62 illustrations. 8¾-in. × 5¾-in.

(Macmillan & Co. Price 15/- net.)

There are many students who have mastered the easier parts of the Differential and Integral Calculi, and who desire to apply the powers thus acquired to the understanding of the celestial motions. They could not select a better book for their purpose than the present volume. A large portion of it would be easily within their grasp. It contains all the introductory matter on forces, accelerations, and laws of motion, so that it is complete in itself, and needs no accompanying textbook on Dynamics. It contains many interesting physical digressions, such as the escape of planetary atmospheres, and the meteoric and contraction theories of solar energy. There is also a study of the question whether the observed orbits of double stars furnish a proof of the existence of gravitation in these systems. This cannot be proved with mathematical precision from the observed facts, but it is shown to be a moral certainty. An explanation is given of the graphical solution of Kepler's problem by means of a sine-curve, which is very useful in the case of orbits of large eccentricity. There is also an introduction to the method of development of functions in series of sine-terms.

Attention will naturally be turned to the chapter on the Determination of Orbits, for since Watson's "Theoretical Astronomy" has gone out of print there has been a dearth of works in English dealing with this subject. The author's treatment of it is mainly from a theoretical standpoint, and scarcely full enough to be clear to the beginner, who also needs some actual numerical examples to be fully worked out. Still, all will enjoy the chapter as a lucid and orderly presentment of the various methods: it includes Professor Charlier's recent results on the regions where there are two orbits satisfying the three observations, and those where there is only one.

The following chapters give an outline of the planetary motions, and a discussion of easier cases of the problem of three bodies, including the five exact solutions. One of these is the Straight Line solution; its possible connection with the phenomenon of the Gegenschein is discussed; it is not stable motion, so no particular particle could remain long in the required position, but if the supply of meteoric matter is sufficient, new particles might continually replace those that moved away. Another interesting case is the equilateral triangle solution; practical examples are now known in the solar system, viz., the Trojan group of Asteroids, which make an equilateral triangle with the Sun and Jupiter. The criterion for stability is shown to be that the mass of the perturbing planet should not exceed ·0385. As the mass of Jupiter is only one-fortieth of this limit the motion of these asteroids is stable.

The final chapters give both geometrical and analytical explanations of the more interesting perturbations of the Moon and planets: the method of mechanical quadratures is briefly explained, and its advantages and disadvantages, compared with the method of expansion in series of sine-terms, are pointed out. The book closes with some general reflections, the final sentence being: "As the telescope has brought within the range of the eye of man the wonders of an enormous space, so Celestial Mechanics has brought within reach of his reason the no lesser wonders of a correspondingly enormous time. It is not to be marvelled at that he finds profound satisfaction in a domain where he is largely freed from the restrictions of both space and time."

A. C. D. Crommelin.

BIOLOGY.

The Country Month by Month.—By J. A. Owen and G. S. Boulger. 492 pages. 32 illustrations, of which 12 are in colour. 9-in. × 6-in.

(Duckworth & Co. Price 6/- net.)

The interest which is taken in Field Natural History and the usefulness of the book before us are shown by the fact that the latter, since its publication in 1901, has been reïssued, and now appears again in a new edition with coloured plates. Mrs. Jean A. Owen, who edited the well-known series of books by "A Son of the Marshes," is responsible for the chats on Birds and other Vertebrates, while Professor Boulger contributes the chapters dealing with Plants and Insects. Furthermore, the late Lord Lilford, on reading the first edition, made a number of interesting comments with the idea that they might be incorporated in a second; and these have now been added, with the result that still another interest is given to the book. To those who are not familiar with it we would say that, as its title suggests, it gives an account of the changing face of the country, and its wild life, in the form of a regular calendar of the seasons, and we commend it to lovers of nature who need some guidance, or who wish to be reminded of what they may expect to see at various times of the year. It is far, however, from being a mere category. Incidentally all kinds of facts, anecdotes, and theories, not to mention poetic extracts, are introduced, which make it worthy of a place in the literature of the country.

W. M. W.

CHEMISTRY.

The Simpler Natural Bases.—By G. Barger, M.A., D.Sc. 215 pages. 9¾-in. × 6-in.

(Longmans, Green & Co. Price 6/- net.)

This latest addition to the series of Monographs on Biochemistry deals with those groups of nitrogenous compounds in animals and plants, which are of a basic nature, but have a more simple structure than the alkaloids. They

include the amino compounds to which Brieger gave the name of "ptomaines," produced in the putrefaction of proteins; creatinine, and the other meat bases; and the curious base adrenaline, which occurs mainly in the supra-renal gland. The distribution, constitution, and chemical and physical properties of these bodies are fully dealt with, and there is also a good outline of the physiological properties of adrenaline and the ptomaines. Practical methods of isolating and identifying the different bases and a description of their principal salts are given in an appendix, the sections of which correspond to the different chapters in the book. As in the case of the other monographs in this series, there is an excellent classified bibliography, and the book should meet with a warm welcome from every biologist and chemist whose work is concerned with food products.

C. A. M.

Elements of Qualitative Chemical Analysis.—By J. Stieglitz. 2 vols. 312 and 153 pages. 8¾-in. × 6-in.

(G. Bell & Sons. Price 6/- each volume.)

The two volumes of this book embody the author's experience as a teacher of chemistry, and are an amplification of the lectures given by him during the past sixteen years. In the first volume the fundamental chemical theories of osmotic pressure, ionisation, chemical and physical equilibrium, and so on, are discussed, and their application in qualitative analysis is clearly shown, although, for the most part, the use of physico-chemical methods is restricted within the limits implied by the title. In the second volume the group reactions are systematically studied, and an outline is given of a course of qualitative analysis, which is mainly confined to inorganic substances. Throughout the book stress is rightly laid upon the importance of keeping a quantitative point of view in mind, and Professor Stieglitz appears to share the view of many teachers of chemistry that qualitative chemistry should be made quantitative. The two volumes are intended to be used together, and the student who has mastered them cannot fail to be an expert analyst.

C. A. M.

ECONOMICS.

The Government of Man: an Introduction to Ethics and Politics.—By G. S. Brett, M.A. (Oxon). 318 pages. 7¼-in. × 4¾-in.

(G. Bell & Sons. Price 3/6 net.)

As Mr. Brett remarks in his Preface, "The study of ethical theories is too often conducted with no immediate reference to the historical setting of each theory; even political science is often divorced from the events which gave vitality to the theories; and every experienced teacher knows the practical difficulty of supplying a background for the continuous development of theories." His book is an attempt—a very successful attempt on the whole, I think—to cope with that difficulty; but it is not intended to be a history of politics, ethics, or economics.

In the first part, occupying about half the volume, the theories and practice of the ancient world are discussed, where that term is taken to mean Greece and Rome; the second part deals with the mediaeval period in Europe; while the third brings us up to the time of John Stuart Mill.

The chief criticism that may be passed is that the discussion is too restricted in a geographical sense. There were ancient systems of civilisation other than those of Greece and Rome; and in dealing with the modern period the author restricts himself almost entirely to English writers on ethics and politics.

But the book contains much that is interesting and stimulating to thought. As the author points out, the family forms the unit of all primitive organisations. "No one thing in the history of the world," he says, "has had more effect than the natural overlapping of the generations." Here we can find the origin of the concept of kingship; but the primitive king almost inevitably degenerates from a father to a tyrant, as his family grows until it is no longer a true family.

As the author shows, although the nobility of Europe did something to foster noble ideals of loyalty and high breeding, "there has never been a more fruitful source of corruption than hereditary titles and positions; for the control of others has too often descended by right of birth to those who had never learnt to control themselves"; and, as he points out, a form of republicanism "seems to be the inevitable consequence of progress and enlightenment."

The history of the government of man is a curious and, in a way, a tragic history. We can see the conflict between the concept of government as power and the concept of government as an applied science. Plato, in his immortal work, has formulated the latter idea, and it is once more coming to the fore. But, as ever in this history, practice lags behind theory. We may see, too, the conflict of reason with prejudice and convention. The ethical and political writers of the eighteenth and early nineteenth centuries represent reason in its least satisfactory aspect. They forget the existence and power of the emotions. It would not be fair, however, to say this of Mill, whose views, one gathers, have Mr. Brett's support. Had Mill only realised the true significance of religion, he might well have formulated a completely satisfactory theory of ethics.

Mr. Brett claims to have written without bias, and, on the whole, I think he has done this, though, as I have said, one can tell where his sympathies lie. It is regrettable, I think, in view of the general misunderstanding of that word, that he should have referred to Rome's system of feeding its unemployed wastrels at the expense of industrious provincials as "a vast system of State Socialism." But, not to end on a note of criticism, let me finish by quoting from the book an altogether excellent passage, relating to the views of the Utilitarian school: "To take pleasures and pains as the basis for measuring social progress is to cast away the 'indefeasible rights,' which were obviously producing and increasing the misery of the people. To assert that every man should count for one, and one only, is to recognise that in a free country there must be freedom of opportunity and of action, limited only by the existence of a majority that opposes the action."

H. S. Redgrove.

PHYSICAL CHEMISTRY.

The Viscosity of Liquids.—By A. E. Dunstan and F. B. Thole. 91 pages. 12 figures. 62 tables. 8¾-in. × 6-in.

(Longmans, Green & Co. Price 3/- net.)

This book is one of a series of monographs on Inorganic and Physical Chemistry issued by the above publishers under the editorship of Dr. Alexander Findlay. The avowed aim of this series is to assist students preparing for an Honours Degree or those undertaking research, and the present book is written in conformity with this design. The authors have culled information on the subject of viscosity from no fewer than one hundred and thirty-six published papers—to which full references are given—and have succeeded in placing before the reader a comprehensive view of the present state of our knowledge regarding the viscosities of liquids. The readers for whom the book is intended may, in consequence, make themselves acquainted with the various aspects of the subject, without having to spend a considerable amount of time in searching for information scattered through the pages of various scientific journals, and will therefore find the book of great assistance.

Allowing for the somewhat narrow audience the book is intended to reach, there are few criticisms to offer. The abbreviated heading of the right-hand pages of Chapter IV—"Viscosity of Pure Liquids subsequent to 1895"—is ambiguous, and might be better worded. In most of the graphs no numerical values are assigned to the coördinates, although points representing actual observations are of frequent occurrence. The result of this is to render the

graphs qualitative only, when a slight addition would have enabled quantitative values to be read also, and the checking of the results of new experiments against previous figures thus facilitated. This omission is probably due to the fact that the view of the book is comprehensive rather than detailed.

The book contains nine chapters, the first of which is devoted to formulae; the second to experimental methods; the third and the fourth to the values obtained by various workers for the viscosities of pure liquids; the fifth to liquid mixtures; the sixth to electrolytic solutions; the seventh to colloids; the eighth to the relation between viscosity and chemical constitution; and the ninth to special applications of viscosity. Many interesting relations between the viscosities of allied chemical compounds are brought out, and the importance of viscosity as an aid to the elucidation of chemical problems clearly established.

From the standpoint of the general reader, the restricted scope of the book is a drawback. It can only be read with advantage by those who already possess a clear conception of the meaning of viscosity and a fairly advanced knowledge of chemistry. Little mention is made of the use of viscosity tests for commercial purposes, the test devised by Schidrowitz for the evaluation of rubber being the only one referred to. Such an important question as the viscosity of lubricating oils does not find a place in the book, although, from the standpoint of the average chemist, a knowledge of this branch of the subject is at least equal in value to that of the viscosities of a series of organic compounds. It must be remembered, however, that the book has been written for special, and not for general, readers; but so well have the authors achieved the limited task allotted to them that one cannot but regret that the occasion did not permit them to produce a volume of a more general character, and adapted to a wider circle of readers.

Chas. R. Darling.

NOTICES.

MR. MURRAY'S QUARTERLY LIST.—Among the forthcoming works in Mr. Murray's Quarterly List we notice the following, which are of particular interest to our readers: "Trees and Shrubs hardy in the British Isles," by W. J. Bean; "Life Histories of African Game Animals," by Theodore Roosevelt and Edmund Heller; "Practical Tropical Sanitation," by W. Alex. Muirhead; "Hunting Pygmies," by William Edgar Geil; and the ninth edition of Fream's "Elements of Agriculture," edited by J. R. Ainsworth-Davis.

THE MARTIN KELLOGG FELLOWSHIP.—*The Evening Post* (New Zealand) says that a distinction is conferred upon New Zealand by the awarding of a Martin Kellogg Fellowship in the Lick Astronomical Department of the University of California to the Government Astronomer, Mr. C. E. Adams, M.Sc., F.R.A.S. The fellowship was endowed by Mrs. Louise W. B. Kellogg in memory of her husband, Martin Kellogg, whose services in the University of California, as professor and president, covered nearly half a century. The purpose of the fellowship is to provide opportunities for advanced instruction, and for research, to students who have already received the degree of Doctor of Philosophy, or an equivalent, or to members of staffs of observatories. The Lick Observatory, situated on top of Mount Hamilton, California, is probably the best-known observatory in the world. It was founded in 1876 under the will of Mr. James Lick, a Californian millionaire, and in 1888 was transferred to the University of California. It is splendidly equipped with instruments of astronomy, and in investigational work has been exceedingly fruitful. It is estimated that the instruments on Mount Hamilton are from two to five times as fruitful and efficient as those of similar observatories under ordinary climatic and local conditions. A large proportion of the principal astronomical discoveries of the last quarter of a century has been made at the Lick Observatory.

THE CAWTHRON SOLAR OBSERVATORY.—The President of the Wellington Philosophical Society, Dr. C. Monro Hector, recently gave an address, which is reported in the *Evening Post* (New Zealand), to the members of the Society on the subject of the establishment of the Cawthron Solar Observatory at Nelson. After alluding to the good work done by Miss Mary Proctor, the munificent gift of Mr. Thomas Cawthron, of Nelson, and to the report furnished by Mr. Evershed (in charge of the Kodaikanal Solar Observatory in India) on the proposed sites at Nelson, Dr. Hector summarised the present position in regard to the observatory as follows:—

(1) The establishment of a solar observatory in New Zealand has the cordial approval of the leading authorities in Europe and America, and offer of all possible assistance from the Royal Astronomical Association.

(2) Meteorologically the neighbourhood of Nelson is suitable. The records show that it has twenty per cent. more sunshine and thirty-three per cent. less rain than at Kodaikanal Solar Observatory, in India.

(3) Several excellent sites are available within a short distance of Nelson.

(4) Examination of these sites by a recognised expert has shown that the conditions are excellent for solar work.

(5) Of the sites available, that on the Port Hills, within easy reach of the town, has so far proved the best from an observatorial point of view.

(6) The adoption of this site will mean an enormous saving in initial outlay and running expenses.

(7) The estimated minimum sum required to establish an observatory competent to give continuous service equivalent to that of northern observatories is £30,000.

(8) Mr. Thomas Cawthron has promised to give £30,000 for a beginning.

(9) A suggested deed of trust has been drawn up, and a suggested Board of Trustees has been submitted to Mr. Cawthron for his approval.

(10) Mr. Cawthron has generally expressed his approval of the above.

In the picture of the approved site, the location is shown on the hill at the rear side of the Boys' College, and Dr. Hector stated that it is in close proximity to the new Queen's Drive that Mr. Cawthron is presenting to the city of Nelson.

The proposed constitution of the Board of Trustees of the Cawthron Observatory is as follows:—Mr. Thomas Cawthron, one member nominated by each of the following bodies: Nelson Philosophical Institute, Board of Governors of the Nelson College, Nelson City Council, New Zealand Institute, the Council and Professorial Board of Victoria College (acting together), University of New Zealand, the Council of the Astronomical Section of the Wellington Philosophical Society, the Surveyors' Board, the Government Astronomer, *ex officio*, and two others to be elected by the rest of the board.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

SEPTEMBER, 1914.

A WANDERING LICHEN.

(*Parmelia revoluta* var. *concentrica* Cromb.)

By ROBERT PAULSON, F.L.S., and SOMERVILLE HASTINGS, M.S.

THIS plant was first found on Melbury Hill, near Shaftesbury, Dorsetshire, in 1855, by Sir William Trevelyan, and notes respecting it appeared in the *Gardeners' Chronicle* for February 9th and March 15th, 1856, followed by the familiar initials, M. J. B. It is described there as a spherical, unattached lichen, which rolls on the exposed downs, and it was suggested by Trevelyan that certain of the Parmelias were blown off the trees and carried for a considerable distance to the downs by the west or south-west winds, to which the spot, where the specimens were collected, is much exposed; and that there, lodged among the short herbage, they continued to grow, though liable to be rolled about continually by the wind. Crombie endorsed these views, for in a communication to the *Journal of Botany*, in 1872, he writes: "This curious variety occurs on the ground in a free condition as small globular balls. There is no reason to suppose that it is free *ab initio*, but that, after being detached, it assumes this form from accidental circumstances." While at Braemar, in 1872, he saw a peculiar form of *Parmelia omphalodes* Ach. rolled about by the wind on the detritus of Morrone, one of the N. Grampians. He says, in the note already referred to, that it is a state analogous to *Parmelia revoluta* var. *concentrica*, but that the masses are not so spherical. He named it *Parmelia omphalodes* (*form* 2) *sub-concentrica*, and concluded it originated from var. B of *P. omphalodes panniformis* by nodular excrescences of the thallus becoming detached from the rocks on which the lichen grew. Probably it was the sight of this that caused him to give so decided an opinion on the origin of the Melbury specimens. We have not succeeded in finding any recent records of the Melbury plant, nor does it appear in any of the Continental floras that we have consulted.

Specimens of the lichen we are about to describe were first found on the downs near Seaford, in August, 1904, by D. J. Scourfield, who sent it to friends whom he thought might be interested. On that occasion we received a small portion of a specimen, but had no opportunity then of following it up. E. M. Holmes secured some further specimens from Seaford about four years ago, and exhibited some of them at a meeting of the Linnean Society, and made a few comments on its wandering habit.

The writers have recently spent some time near Seaford investigating this plant. On searching the downs between Eastbourne and Seaford no traces of the lichen were found, except over a small area of about eight acres on the Seaford Downs. This area, apparently, presents no peculiar features. It slopes gently towards the west, and is fully exposed to the south-west winds. It is covered by the turf of a chalk down, with occasional patches of stunted gorse. Over most of the area the lichen is freely distributed, as will be seen by Figure 309, which is quite typical of the whole habitat, but it is not found at all amongst the stunted gorse bushes. A number of flints are scattered over the turf,

and these are perhaps slightly more numerous at this place than on the downs generally. At one point, near the centre of the area, the lichen was much more abundant than in any other part.

The specimens collected at Seaford (see Figure 310) vary considerably in shape and size, and measure from one to seven centimetres in longest diameter. Very few are spherical, some are more or less flattened, and many are quite irregular. They rapidly absorb water, and while they are wet they are exceedingly soft and spongy. In this condition they rapidly break up into small fragments. Our specimens were gathered after six or eight weeks' drought. On placing some of them in water a few days after collection, it was quite easy to determine which side had been uppermost for some time before gathering. In water, the uppermost side became pale green in colour (they are greenish grey when dry); the underside remained unchanged. New growth probably takes place only on the exposed surface. This is similar to the growth of some allied, attached lichens, as that of *Parmelia omphalodes* and some forms of *Parmelia saxatilis*. The older portion is continually being covered over by younger branches, and thus the thallus shows a succession of layers.

When the plant approaches a spherical form in unattached specimens, the layers approximate to a concentric arrangement (see Figure 311), but there are often more layers in one part than in another; many of them have a hollow space in the interior. The greater number of layers on one side is perhaps accounted for by the specimens having remained on the ground in an undisturbed condition for a lengthened period, and the growth having taken place over the portion exposed to light. Before it was suggested that such erratic lichens commenced development on the branches of trees, it was thought that there might be a nucleus of growth, as a portion of rabbit's dung, or a small stone, and it was while looking for indications of such that the contents of some of the masses were noted. They all contained minute grains of sand—blown, no doubt, from the seashore—and the decaying matter of the innermost layers. After soaking in water for twenty-four hours each of six different specimens examined contained a few living and very active Bdelloid rotifers. These rotifers have been known for some time as moss-dwellers, but lichens must now be added to the list of their habitats. When dry, the lichens are comparatively light, and are probably occasionally rolled over by a strong wind. It is well to remember that with the south-west gales there is frequently heavy rain, and that by the soaking up of water the plants become comparatively heavy. Owing to the rough external structure of the thallus, these lichens come into contact with the grass at many points (see Figure 309), and this must prevent movement except when there is a very strong wind. The following results were obtained on weighing three specimens, first when dry, and then after they had been in water twenty-four hours:—

1.	Dry	·97 grm.	...	Wet	5·02
2.	,,	1·14 ,,	...	,,	7·04
3.	,,	1·04 ,,	...	,,	6·22

They are thus from five to six times heavier when thoroughly wet than when quite dry.

The thallus is moderately smooth, subcartilaginous and greenish-grey. The edges of the minute rounded, and overlapping lobes (see Figure 310) are rolled towards the under surface (revolute), producing at the end of the lobe a small hood, and making the exterior of the ball-like masses exceedingly rough to the touch. The lobed and involved (panniform) nature of the thallus produced by the revolute character and overlapping of the lobes is shown in Figures 310 and 312, the last being an enlarged portion ($\times$ 4) of the outer surface. There are no fruits (apothecia), and very few of the powdery masses (soredia), a vegetative mode of reproduction; but spermagones are fairly numerous in certain parts of the thallus of some of the older plants. The spermagones are seen as small black spots in Figure 312; each is a flask-shaped receptacle, from the interior of which minute cells are constricted. These cells are regarded either as spores or as non-motile male cells. The branches of the thallus that grow out from the margin to cover up the exposed inner portion of a broken fragment (see Figure 313) are broader, scarcely revolute, and slightly rugose, but these broader branches are in the course of time covered over by others that gradually assume the narrower revolute form. These differences, noted in the thallus at various periods of growth, have been the reason for the difficulties experienced by the older lichenologists in rightly placing this plant. The inner surface of the thallus is very dark, almost black, and is covered by numerous dark fibrils. This structure can be made out by cutting through the centre of one of the ovoid masses (see Figure 311), when the clear white medulla of the thallus and the cavity within become prominent features. One of the tests for the identification of this lichen is the application of a solution of calcium hypochlorite to the white medulla, which turns reddish. The action of this reägent on the plant on flint described below (see Figures 314 and 317) and on the free plant is exactly the same; but one could scarcely doubt the essential identity of the two, even without this test. On comparing the lichen as it grows upon the flint (see Figure 317) with a free plant, one finds only very slight differences. The revolute character is perhaps not quite so evident in the attached specimen, and the thallus is not so congested.

There is no apparent evidence that the Seaford specimens commenced growth on the branches of trees. The nearest trees to the spot where the lichen is found are Sycamores, about three-quarters of a mile away, and on these the following lichens are

FIGURE 309.
Four specimens of *Parmelia revoluta* var. *concentrica*, photographed exactly as found on the chalk downs. × 1.

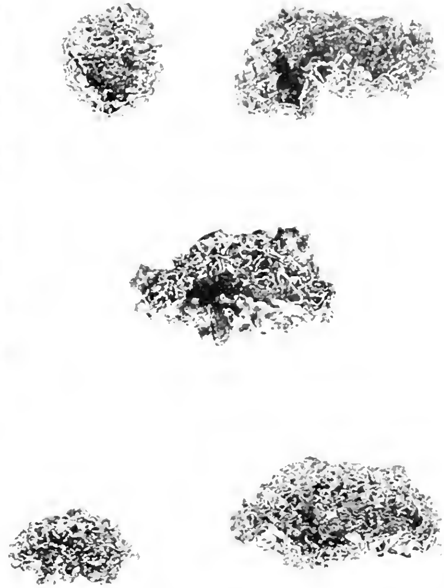


FIGURE 311. Five Lichens in section. The concentric arrangement of the layers and the central cavity in some specimens will be seen. × 1.

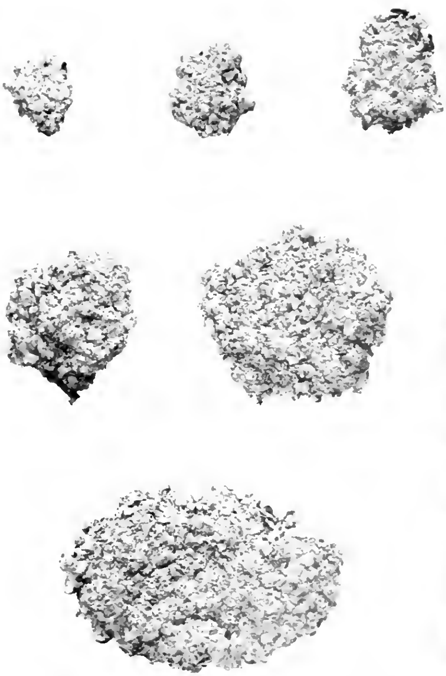


FIGURE 310.
The upper exposed surfaces of six specimens of different sizes. × 1.

FIGURE 312. The upper surface of a large specimen showing the imbricated arrangement of the branches. × 4.

Parmelia revoluta var. *concentrica* from photographs by S. Somerville Hastings.

Figure 313.

Six small specimens probably [illegible] recently detached from bigger ones. The large branches of the thallus growing rapidly to cover in the broken surfaces are well seen. × 1.

Figure 314.

Parmelia revoluta var. *panniformis* on a flint stone, photographed just as it was found. The detached fragment lying beside fitted exactly into the vacant space. × 1.

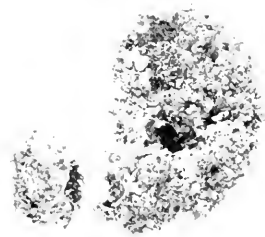


Figure 316.

A second specimen of *Parmelia revoluta* var. *concentrica* recently broken. It is in this way that the lichen is multiplied. × 1.

Figure 315.

A specimen of *Parmelia revoluta* var. *concentrica* found recently broken into two parts. × 1.

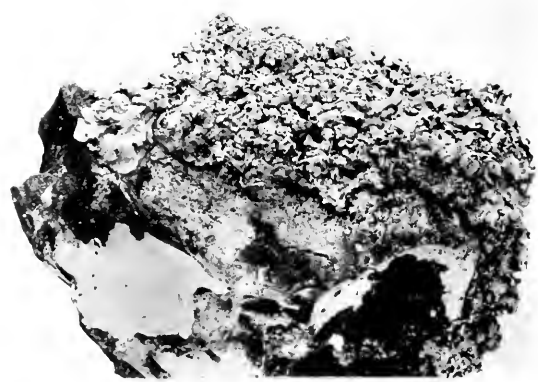


Figure 317.

Parmelia revoluta var. *panniformis* growing on a flint stone. The larger size of the branches at one side of the lichen should be noted. × $1\frac{1}{2}$.

Parmelia revoluta vars. from photographs by Somerville Hastings.

abundant: *Platisma glaucum*, *Everia prunastri*, *Parmelia sulcata*, *P. caparata*, *P. physodes*, *Physcia parietina*, *P. pulverulenta*, *P. tenella*, *Pertusaria communis*, *Lecidea parasema*, *Buellia canescens*, and *B. myriocarpa*. No trace of *P. revoluta* was discovered. On the bushes, fences, and flint stones near the area the following lichens were found: *Parmelia physodes*, *Physcia parietina*, and *Lecidea parasema* on bushes; *Ramalina calicaris*, *R. farinacea*, *R. fastigiata*, *Parmelia sulcata*, *P. caparata*, *Physcia polycarpa*, *Lecanora symicta* and *L. chlarona* on fences; *Physcia parietina*, *P. tenella*, *Lecanora murorum*, *L. atra*, *L. gibbosa*, *L. galestina*, *L. Paretta*, *Rhizocarpon confervoide*, and *Verrucaria nigrescens* on flints.

But on four flints only, out of several hundreds in the area we are describing, specimens of *P. revoluta* with panniform structure were found. Curiously enough, all these flints occurred towards the northen extremity of this area. While growing on the stone, the lichen assumes a panniform condition (see Figure 317), or, in other words, is built up of a series of superimposed imbricating layers. One of these stones (see Figure 314) was of peculiar interest, for lying close beside the lichen-covered flint was a detached piece, which fitted exactly into a vacant space upon the stone. It had evidently fallen off, or had been knocked off very recently. There can be no doubt that such a fragment as this might readily grow to such a typical specimen as is shown in Figure 310. We are not of the opinion that the very numerous specimens found on this small area all had their immediate origin from growth on a flint stone. From specimens collected, it appears evident that a small detached fragment is capable of growing to the size of that of the largest specimens found. Very few of these lichens growing on flints were met with, but several specimens were seen which had recently been broken into two pieces (see Figures 315 and 316). A flock of sheep driven across the downs where the lichens are found would effectually break up a great many of them, particularly on a wet day.

The wandering habit of this plant is quite unique among British lichens, but has some similarity with that of *Lecanora esculenta*, the manna of the Bible, which at certain seasons of the year breaks off from the rocks on which it grows in small masses, and is carried away by the wind, or is perhaps more frequently washed away by the rain. Kerner, in his "Natural History of Plants," Volume II, mentions the so-called rains of manna, news of which comes periodically from the East. It is clear that *P. revoluta concentrica* is blown about by the wind, but why it should be confined to so small an area is less easy to explain. It does not seem at all probable that all other parts of the downs to which it may be blown are unsuitable for its continued growth and development.

CORRESPONDENCE.

RUSSIAN PEASANTS' ARITHMETIC.

To the Editors of "KNOWLEDGE."

SIRS,—The interesting method of finding the product of two numbers, described by the Rev. G. T. Johnston, may be explained as follows:

$$\begin{array}{ll}
(2^4 + 2^3 r + 2^2 r_1 + 2 r_2 + r_3) \times n & \\
\cancel{2^3 + 2^2 r + 2 r_1 + r_2} & \cancel{2n} \\
2^2 + 2r + r_1 & 2^2 n \\
\cancel{2 + r} & \cancel{2^3 n} \\
1 & 2^4 n
\end{array}$$

The formation of the right-hand column is obvious. On the left side r, r_1, r_2, and so on, represent the different remainders. Their value may be 1 or 0. Working upward from 1, each successive line is formed by doubling the previous line and adding the remainder. Now let any of the remainders $= 0$, say r and r_2. Then the second and fourth numbers on the left are even, and on the first line the terms $2^3 r$ and $2 r_2 = 0$. The left-hand factor now becomes $2^4 + 2^2 + 1$, or 21, and the right side shows the product to be $n\,(2^4 + 2^2 + 1)$. Arithmetically, if $n = 23$, the result is:

$$\begin{array}{rr}
21 \times & 23 \\
\cancel{10} & \cancel{46} \\
5 & 92 \\
\cancel{2} & \cancel{184} \\
1 & 368 \\
 & \overline{483}
\end{array}$$

It will be noticed that any whole number is resolvable into the sum of part of the terms of the series 1, 2, 2^2, 2^3, and so on, *e.g.*; $77 = 64 + 8 + 4 + 1 = 2^6 + 2^3 + 2^2 + 1$.

BRIGHTON. E. J. PETITFOURT.

ALKALOIDS AND COLOUR CHANGES.

To the Editors of "KNOWLEDGE."

SIRS,—The following, if new, may be of interest to some of your readers.

If into about five to ten drops of a $\frac{1}{10}$ solution of nicotine in amyl alcohol one drop of a strong solution of phosphotungstic acid (thirty grammes of soda tungstate and fifteen grammes of phosphoric acid, specific gravity 1·5, digested for some days and dissolved in two ounces of water) is allowed to fall from a height of about one-eighth inch, the drop spreads out to form a transparent disc about ·7 centimetre in diameter. Viewed by reflected light, and preferably under a low power ($\times$ 20) of the microscope, the disc exhibits a series of colour changes, commencing with yellow, and running through orange, red, violet, and blue, to green, in the space of ten to fifteen seconds. This process is then repeated two or three times. The third and fourth series of changes are very slow, and the colours become gradually less distinct. The disc finally becomes white. During the first series of changes the colours are most pure and brilliant, but no colour can be perceived by transmitted light. Similar effects are produced by a solution of the oxalate of nicotine in ethyl alcohol and of nicotine in water, petroleum, ether, and chloroform. Probably they are due to the formation and gradual thickening of a film separating the two reägents.

I should be grateful if any of your readers could tell me whether the reäction constitutes a serviceable test for the alkaloid.

J. G. DREW.

THE HANNINGS,
FRESHFIELD ROAD,
BRIGHTON.

THE FACE OF THE SKY FOR OCTOBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 42.

Date.	Sun. R.A	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°
Oct. 5	12 41·0	S. 4·5	1 27·0	N.13·4	14 5·6	S.14·8	15 31·8	S.23·8	21 0·9	S.18·0	6 9·7	N.22·3	20 41·4	S.19·0	8 9·3	N.19·7
,, 10	13 0·2	0·4	5 36·0	N.28·2	14 29·2	17·3	15 48·1	25·0	21 0·8	18·0	6 10·0	22·3	20 41·2	19·0	8 9·6	19·7
,, 15	13 18·7	8·3	10 6·8	N.12·2	14 50·6	19·4	16 3·0	26·0	21 1·1	18·0	6 10·1	22·3	20 41·1	19·0	8 9·9	19·7
,, 20	13 37·4	10·1	14 39·2	S. 20·5	15 7·9	20·8	16 16·2	26·8	21 1·6	18·0	6 10·0	22·3	20 41·1	19·0	8 10·1	19·7
,, 25	13 50·4	11·0	19 53·6	S. 24·1	15 18·1	21·4	16 27·1	27·4	21 2·5	17·9	6 9·7	22·3	20 41·2	19·0	8 10·2	19·7
,, 30	14 15·0	S.13·0	23 50·1	N. 1·2	15 16·8	S. 20·7	16 35·0	S. 27·7	21 3·7	S.17·8	6 9·2	N.22·3	20 41·4	S.19·0	8 10·3	N.19·7

TABLE 43.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
Oct. 5	+ 26·3	+6·5	171·0	−20·8	−18·4	+0·1	10·5	299·4	9 34 *e*	11 37 *e*
,, 10	26·4	6·2	105·1	− 3·0	18·4	0·1	79·7	330·4	9 50 *m*	2 54 *m*
,, 15	26·3	5·8	39·1	+19·0	18·4	0·1	148·8	1·4	5 47 *e*	9 54 *e*
,, 20	26·1	5·4	333·2	+17·3	18·4	0·1	217·8	32·2	3 54 *e*	11 8 *m*
,, 25	25·7	5·0	267·2	− 9·7	18·5	0·1	286·6	62·9	4 11 *m*	0 21 *m*
,, 30	+ 25·0	+4·5	201·3	−22·1	−18·5	+0·1	355·4	93·6	9 59 *e*	7 22 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}8$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving southward but with slackening speed. Its semi-diameter increases from 16′ 0″ to 16′ 8″. Sunrise changes from $5^h\ 59^m$ to $6^h\ 53^m$; sunset from $5^h\ 41^m$ to $4^h\ 35^m$.

MERCURY is an evening star, at elongation 25° from Sun on 15th. Semi-diameter increases from 3″ to 4½″. Illumination diminishes 0·8 to 0·2.

VENUS is an evening star, ⅓ of disc illuminated. Semi-diameter 18″. At greatest brilliancy on 23rd. The fact of its declination being south of the Sun impairs the conditions of observation for northern observers. It has passed elongation, and is approaching the Sun.

THE MOON.—Full $4^d\ 5^h\ 59^m$ *m*. Last quarter $12^d\ 9^h\ 33^m$ *m*. New $19^d\ 6^h\ 33^m$ *m*. First quarter $25^d\ 10^h\ 44^m$ *e*. Apogee $6^d\ 5^h$ *e*. Perigee $19^d\ 4^h$ *e*, semi-diameter 14′ 44″, 16′ 45″ respectively. Maximum librations 8^d 7° S., 13^d 7° E., 21^d 7° N., 25^d 7° W. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 45).

MARS is practically invisible.

JUPITER is an evening star, in Capricornus, 26′ South of θ Capricorni on September 30th and on October 16th. Polar semi-diameter, 20″. Stationary on 9th; 1° N. of Moon on 26th.

Configuration of satellites at 8^h *e* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.	
Oct. 1	431	○	2		Oct. 17	3412	○		
,, 2	432	○	1		,, 18	43	○	12	
,, 3	431	○		2 ●	,, 19	412	○	3	
,, 4	4	○	12	3 ●	,, 20	42	○	13	
,, 5	421	○	3		,, 21	4	○	23	1 ●
,, 6	42	⊙	3		,, 22	413	○	2	
,, 7	4	○	132		,, 23	342	○	1	
,, 8	31	○	42		,, 24	3142	○		
,, 9	32	○	14		,, 25	3	○	142	
,, 10	31	○	4	2 ●	,, 26	1	⊙	34	
,, 11	3	○	124		,, 27	2	○	134	
,, 12	21	○	34		,, 28	1	⊙	234	
,, 13	2	○	134		,, 29		⊙	24	
,, 14		○	234	1 ●	,, 30	32	○	14	
,, 15	13	○	24		,, 31	3^2_1	○	4	
,, 16	32	○	41						

On the 29th, Satellites 1, 3 are both on the disc.

The following satellite phenomena are visible at Greenwich, $1^d\ 10^h\ 35^m\ 56^s$ *e*, II. Tr. I.; $2^d\ 0^h\ 48^m\ 4^s$ *m*, II. Sh. I.; $3^d\ 9^h\ 53^m\ 42^s$ *e*, II. Ec. R.; $4^d\ 8^h\ 25^m\ 28^s$ *e*, III. Oc. R.; $9^h\ 23^m\ 50^s$ *e*, III. Ec. D.; $11^h\ 43^m\ 1^s$ *e*, I. Tr. I.; $5^d\ 9^h\ 2^m\ 34^s$ *e*, I. Oc. D.; $6^d\ 0^h\ 29^m\ 34^s$ *m*, I. Ec. R.; $6^h\ 10^m\ 39^s$ *e*, I. Tr. I.; $7^h\ 19^m\ 53^s$ *e*, I. Sh. I.; $8^h\ 27^m\ 52^s$ *e*, I. Tr. E.; $9^h\ 37^m\ 11^s$ *e*, I. Sh. E.; $7^d\ 6^h\ 58^m\ 23^s$ *e*, I. Ec. R.; $8^d\ 6^h\ 33^m\ 18^s$ *e*, IV. Oc. R.; $10^d\ 7^h\ 9^m\ 32^s$ *e*, II. Oc. D.;

$11^d\ 8^h\ 28^m\ 57^s$ *c*, III. Oc. D.; $12^d\ 0^h\ 7^m\ 59^s$ *m*, III. Oc. R.; $7^h\ 33^m\ 29^s$ *c*, II. Sh. E.; $10^h\ 53^m\ 32^s$ *c*, I. Oc. D.; $13^d\ 8^h\ 2^m\ 2^s$ *c*, I. Tr. I.; $9^h\ 15^m\ 29^s$ *c*, I. Sh. I.; $10^h\ 19^m\ 12^s$ *c*, I. Tr. E.; $11^h\ 32^m\ 44^s$ *c*, I. Sh. E.; $14^d\ 5^h\ 21^m\ 30^s$ *c*, I. Oc. D.; $8^h\ 53^m\ 40^s$ *c*, I. Ec. R.; $15^d\ 6^h\ 1^m\ 39^s$ *c*, I. Sh. E.; $6^h\ 52^m\ 57^s$ *c*, III. Sh. E.; $16^d\ 10^h\ 47^m\ 5^s$ *c*, IV. Tr. I.; $17^d\ 9^h\ 39^m\ 45^s$ *c*, II. Oc. D.; $19^d\ 7^h\ 19^m\ 31^s$ *c*, II. Sh. I.; $7^h\ 38^m\ 3^s$ *c*, II. Tr. E.; $10^h\ 9^m\ 37^s$ *c*, II. Sh. E.; $20^d\ 9^h\ 54^m\ 36^s$ *c*, I. Tr. I.; $11^h\ 11^m\ 9^s$ *c*, I. Sh. I.; $21^d\ 7^h\ 13^m\ 58^s$ *c*, I. Oc. D.; $10^h\ 48^m\ 57^s$ *c*, I. Ec. R.; $22^d\ 5^h\ 39^m\ 32^s$ *c*, III. Tr. E.; $5^h\ 40^m\ 5^s$ *c*, I. Sh. I.; $6^h\ 40^m\ 7^s$ *c*, I. Tr. E.; $7^h\ 17^m\ 16^s$ *c*, III. Sh. I.; $7^h\ 57^m\ 21^s$ *c*, I. Sh. E.; $10^h\ 54^m\ 27^s$ *c*, III. Sh. E.; $23^d\ 5^h\ 17^m\ 47^s$ *c*, I. Ec. R.; $25^d\ 7^h\ 4^m\ 42^s$ *c*, IV. Ec. D.; $26^d\ 7^h\ 19^m\ 46^s$ *c*, II. Tr. I.; $9^h\ 55^m\ 54^s$ *c*, II. Sh. I.; $10^h\ 10^m\ 5^s$ *c*, II. Tr. E.; $28^d\ 7^h\ 6^m\ 40^s$ *c*, II. Ec. R.; $9^h\ 7^m\ 39^s$ *c*, I. Oc. D.; $29^d\ 5^h\ 57^m\ 27^s$ *c*, III. Tr. I.; $6^h\ 17^m\ 0^s$ *c*, I. Tr. I.; $7^h\ 35^m\ 49^s$ *c*, I. Sh. I.; $8^h\ 34^m\ 12^s$ *c*, I. Tr. E.; $9^h\ 35^m\ 4^s$ *c*, III. Tr. E.; $9^h\ 53^m\ 6^s$ *c*, I. Sh. E.; $30^d\ 7^h\ 13^m\ 6^s$ *c*, I. Ec. R.

Eclipses will take place to the right of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN is a morning star, in Gemini. Stationary on 15th. Polar semi-diameter 9″. Major axis of ring 44½″, minor 19½″. Angle P $-6°\cdot3$.

Eastern elongations of Tethys (every 4th given) $1^d\ 10^h\cdot9$ *m*, $9^d\ 0^h\cdot2$ *m*, $16^d\ 1^h\cdot4$ *c*, $24^d\ 2^h\cdot6$ *m*, $31^d\ 3^h\cdot8$ *c*; of Dione (every 3rd given) $6^d\ 4^h\cdot7$ *m*, $14^d\ 7^h\cdot8$ *m*, $22^d\ 2^h\cdot9$ *c*, $30^d\ 7^h\cdot9$ *c*; of Rhea (every 2nd given) $4^d\ 10^h\cdot6$ *c*, $13^d\ 11^h\cdot4$ *c*, $23^d\ 0^h\cdot3$ *m*.

For Titan and Japetus E., W. stand for East and West elongations, I for Inferior (North) conjunction, S. for Superior (South) conjunction. Titan $4^d\ 5^h\cdot0$ *m* I, $8^d\ 2^h\cdot0$ *m* W., $12^d\ 2^h\cdot1$ *m* S., $16^d\ 4^h\cdot5$ *m* E., $20^d\ 3^h\cdot7$ *m* I., $24^d\ 0^h\cdot8$ *m* W., $28^d\ 0^h\cdot9$ *m* S; Japetus $14^d\ 3^h\cdot8$ *m* S.

URANUS is an evening star in Capricornus, stationary on 18th, 2° North of Moon on 26th.

NEPTUNE is a morning star, coming into a better position for observation. Stationary on November 3rd.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
July-October ...	355	+ 72	Swift, short.
Aug.-Oct. 2	74	+ 42	Swift, streaks.
Sept. 28-Oct. 9	329	+ 40	Slow small.
Oct. 2 ..	230	+ 52	Slow, bright.
„ 4 ..	310	+ 79	Slowish.
„ 8 ..	77	+ 31	Swift, streaks.
„ 8-14	45	+ 58	Small, short.
„ 14 ..	133	+ 68	Rather swift.
„ 15	31	+ 9	Slow.
„ 18-20 .	92	+ 15	Swift, streaks.
„ 23 ..	100	+ 13	Swift, streaks.
„ 29	100	+ 23	Very swift.

In the cases where the radiant is stated to be active for several months, there is a difference of opinion as to whether it can be regarded as a single shower or a combination of several.

TABLE 44. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
SV Andromedae ...	0 0	+ 39 ·6	8·0 to 13·0	318	Nov. 10.
T Ceti	0 17	− 20 ·5	5·4 to 6·9	162·2	Nov. 15.
T Cassiopeiae.. ...	0 19	+ 55 ·3	6·7 to 12·5	443·0	Dec. 24.
TU Andromedae ...	0 28	+ 25 ·5	7·7 to 11·5	317	Sept. 9.
RV Cassiopeiae ...	0 48	+ 47 ·0	8·0 to 14·5	327	Sept. 6.
R Piscium	1 26	+ 2 ·4	7·0 to 14·0	344·2	Dec. 14.

Minima of Algol $3^d\ 4^h\cdot7$ *c*, $15^d\ 4^h\cdot0$ *m*, $18^d\ 0^h\cdot8$ *m*, $20^d\ 9^h\cdot6$ *c*, $23^d\ 6^h\cdot5$ *c*, $26^d\ 3^h\cdot3$ *c*. Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of β Lyrae October $10^d\ 4^h$ *c*, $23^d\ 2^h$ *c*. Period $12^d\ 21^h\ 47^m\cdot5$.

TABLE 45. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reappearance. Time.	Reappearance. Angle from N. to E.
1914.			h. m.	°	h. m.	°
Oct. 1 ..	λ Aquarii	3·9	6 0 *e*	42	7 8 *e*	255
„ 1 ..	78 Aquarii	6·3	7 31 *e*	26	8 36 *e*	265
„ 7 ..	μ Arietis.	5·7	0 15 *m*	130	0 44 *m*	173
„ 10 ...	BAC 1648	6·4	2 24 *m*	20	3 9 *m*	319
„ 10 ...	BAC 1918..	6·1	—	—	7 59 *e*	327
„ 11 ...	39 Geminorum	6·2	—	—	9 9 *e*	257
„ 11 ...	40 Geminorum	6·3	—	—	9 13 *e*	211
„ 12 ...	Wash. 495	6·9	—	—	3 16 *m*	216
„ 12 ...	BD + 23° 1863	6·7	—	—	11 34 *e*	251
„ 23 ...	BAC 6160	6·4	5 17 *e*	85	6 28 *e*	256
„ 26 ..	η Capricorni	4·8	4 23 *e*	89	5 34 *e*	219
„ 26 ...	Wash. 1407	6·7	7 9 *e*	3	—	—
„ 28 ...	Wash. 1513	6·8	5 12 *e*	129	—	—
„ 28 ...	BAC 7919	6·5	8 3 *e*	1	8 51 *e*	284
„ 30 ...	14 Piscium	5·9	1 39 *m*	7	2 17 *m*	293
„ 31 ...	δ Piscium	4·6	4 45 *e*	98	5 34 *e*	198

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

Comets.—See "Notes on Astronomy" in August "Knowledge." Delavan's Comet promises to be an easy object to the naked eye.

Double Stars and Clusters.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

Variable Stars.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable (see Table 44).

SOLAR DISTURBANCES DURING JULY, 1914

By FRANK C. DENNETT.

During July the Sun was telescopically observed each day, the disc appearing quite free from disturbance on seven days (1st, 15th, and 23rd to 27th), and on nine others (13th, 14th, 16th, 19th to 21st, 28th, 29th, and 31st) only faculae were seen. Outbreaks showed a marked preponderance in the southern latitudes. The longitude of the central meridian at noon on July 1st was 359° 48′.

No. 18.—A somewhat complicated outbreak. At first it was seen on July 2nd, in latitude 37° S., but became reduced to a pore on the 6th and 7th. The more advanced portion developed later, and was the most conspicuous, and was in latitude 32°, and contained a spot at one time seventeen thousand miles in length. The total length of the group was nearly one hundred thousand miles. The preceding portion continued visible until the 12th, but its great faculic remains were seen for two days longer.

No. 19.—A small penumbraless pore, only seen on the 7th.

No. 20.—A group of three pores, twenty-eight thousand miles in length, only seen on July 11th.

No. 21.—Another group of pores, twenty-seven thousand miles in length, showing a considerable amount of change, seen only on the 17th and 18th, containing at one time eight members.

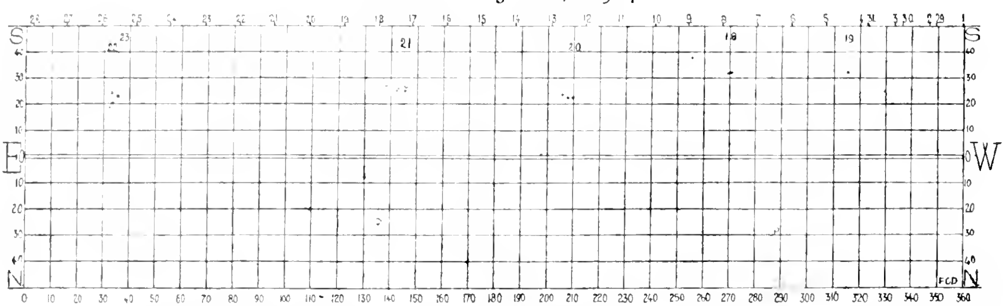
No. 22.—A single pore, on the western side of a faculic disturbance, only visible on the 22nd.

No. 23.—Two pores, the larger leading, in a faculic bed, only seen on the 29th and 30th, but the faculae were visible until the limb was reached on August 1st.

The area in which these last two groups developed was marked by a faculic disturbance near the south-western limb on July 3rd and 4th. No. 20 broke out in a district seen faculic within the south-eastern limb, July 7th to 10th, and within the south-western limb, 17th to 20th. Other faculae were seen north-west, on the 16th and 17th; north-east on 7th, 12th, on chart 136°, 25° N., 13th and 28th, 289°, 30° N.; east on 29th; south-west on the 13th and 14th, 22nd on chart at 139°, 29° S., and 31st; likewise south-east on the 20th and 21st.

Our chart is constructed from the combined observations of Messrs. John McHarg, J. C. Simpson, and the writer.

DAY OF JULY, 1914.



ON THE IDENTIFICATION OF THE NEREIDAE OF PLYMOUTH BY MEANS OF THEIR PARAPODIA.

By W. HAROLD LEIGH-SHARPE, B.Sc., A.C.P.

As it frequently happens that Nereïds die with the pharynx unextruded, so that the denticles, or paragnaths, thereon cannot be observed, and that species described in the text-books as reddish are often green, and *vice versa*, the only safe means of identification is by cutting off the parapodia of an animal, mounting them in a drop of Farrant's medium, and examining them under the low power of a microscope, when one glance at the accompanying figures will clearly determine which of the species is under consideration.

In the figures the following notation is adopted:—

D.c. Dorsal cirrus.

1. The dorsal lobe of the Notopodium (often referred to in books as the Ligula).
2. The ventral lobe of the Notopodium.
3. The dorsal lobe of the Neuropodium.
4. The ventral lobe of the Neuropodium.

V.c. Ventral cirrus.

The acicula are shown as deep black lines. The names in brackets in the descriptions before those of the species are the generic names bestowed upon them by Malmgren, but the differences, it is now universally agreed, are only of specific value, and do not justify the erection of separate genera. Incidentally, at the time he bestowed those names upon them he was ignorant of the meaning of the Heteronereïs form. In general, it may be remarked that—

Nereïs dumerilli and *N. irrorata* may be distinguished by the greater length of their peristomial tentacles (in proportion).

N. fucata lives in the topmost whorls of whelk shells, in those occupied, or recently deserted, by hermit crabs. The peculiarities of its parapodia are visible to the unaided eye.

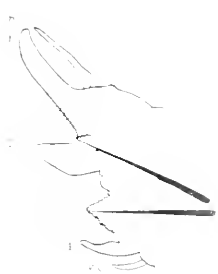
As the parapodia vary slightly in different parts of the body, the examples chosen are selected from as near as possible half-way down the length of the body.

[illegible]
N. cultrifera. [illegible]
(most central type)

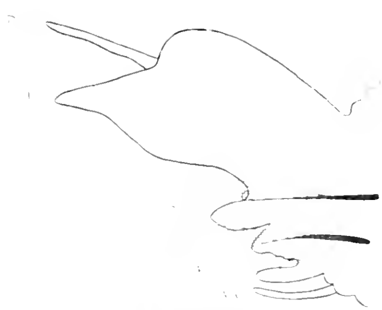
[illegible]
N. [illegible]

FIGURE 21.
N. [illegible]

[illegible]
N. [illegible]



[illegible]
N. Praxiteles? [illegible]



[illegible]
N. [illegible]

Platypodia of Plymouth N[illegible]

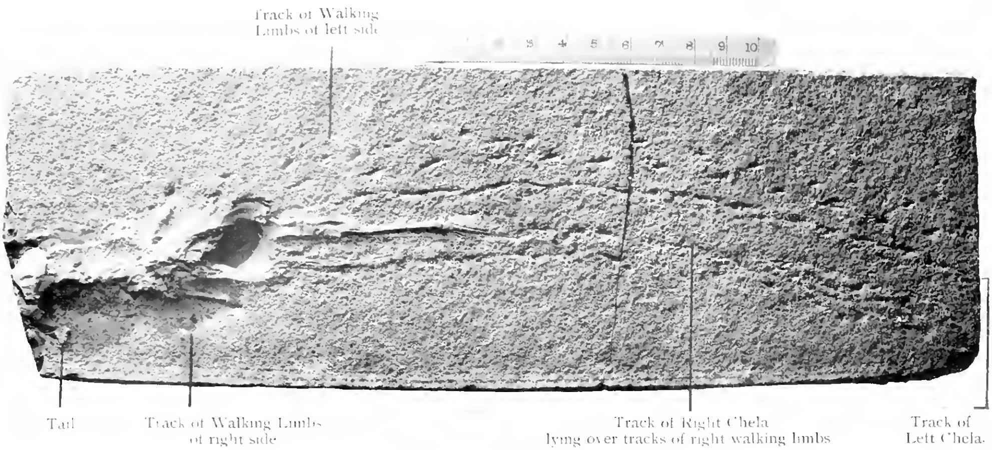


FIGURE 325. The fossil tracks of a dying Lobster (see page 329).

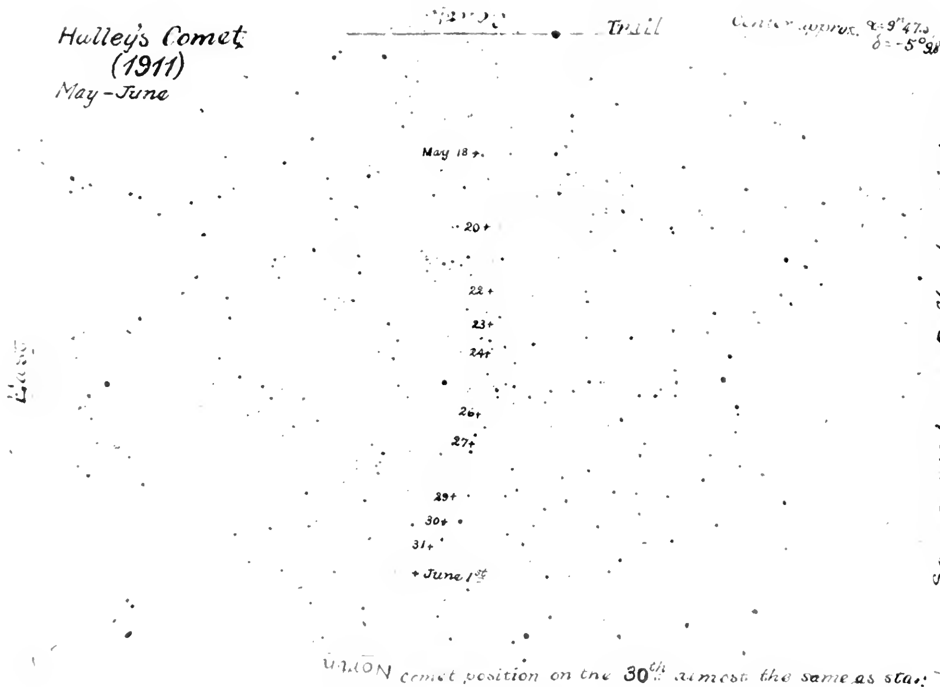


FIGURE 326. Chart of the last views from Earth of Halley's Comet. Photographed at the Lowell Observatory. Near the star ALPHARD (see page 329).

THE FOSSIL TRACK OF A DYING LOBSTER.

By Dr. F. A. Bather, F.R.S.

(By permission of the Trustees of the British Museum.)

In his admirable bionomic study of the Kimmeridgian Plattenkalk of Solnhofen in Bavaria (*Haeckel Festschrift*, Jena, 1904), Dr. Johannes Walther remarks that "the overwhelming majority of crustaceans lie flat and peacefully on the limestone surface, the feet outspread or slightly bent, and usually in connection with the cephalothorax, the long antennae frequently preserved to their very ends, the bristles on the abdominal margin or on the tail clearly raised above the stone; and the completely preserved specimens so predominate that only in *Penaeus* can traces of a death-struggle be suspected. For the rest, no grooving, no sculpture of the limestone surface, suggests any agony. Everyone knows that the living crayfish, when placed in boiling water, bends its tail up under the cephalothorax, and holds it firmly in that position, whereas crustaceans already dead have the body stretched out. It is only in a few slabs with *Aeger* that I have seen the body so bent."

It is therefore interesting to note that the Geological Department of the British Museum has recently acquired a specimen of *Mecochirus longimanus* Münster, one of the Glyphaeidae, which affords direct evidence concerning the last few minutes of its life. The animal lies at one end of a slab of lithographic stone, 29·5 centimetres by 10 centimetres, with its tail, which is curled in, near one end-margin of the slab, and the long chelae, from which the animal derives its name, stretched along the length of the slab. Proceeding from the animal, in the direction of the chelae, are various lines of impressions, indicating that the animal had been crawling backwards. The lines on the left (top in Figure 325), formed by the walking limbs on that side of the body, are the most deeply marked. The reason for this appears from the fact that they are arranged in a wide curve, with a radius of about thirty-two centimetres, so that these limbs were exerting more force than the others as they slewed the animal round. The imprints of the corresponding limbs on the right side are also visible in the immediate neighbourhood of the body, but further away from it are obscured by the tracks of the chelae, which, as the animal curved round, came over the inner lines of track. The chelae do not at present lie immediately on the lines traced by them, but the left-hand one at all events has been swung well over to the right, probably at the moment when the animal finally fell over on its left side and turned up its tail. Even before this it is possible that there were some sweeping movements of the chelae from side to side. The traces of such movement are very obscure, but Dr. Calman, who has kindly examined the specimen with me, thinks that he can see a few faint cross-ridges.

Professor Walther believes that most of the remains of crustaceans, not to mention several other forms of life, found in the Plattenkalk were dead before they were swept into the basin where it was rapidly accumulating. Here, however, we have one that was certainly still alive, and we should like to know just why it died. It was not of old age, for it was by no means so fully grown as many examples of this common species. There are no signs of disease or of any attack by another animal, but the specimen is too poorly exposed to permit of a definite pronouncement on the latter point. Probably the cause was something in the surrounding conditions. The tracks left by various animals (*Archaeopteryx*, among others) are enough to prove that the water was in many places very shallow indeed, often, it may be, little more than a film, if, indeed, the bottom was not temporarily exposed. In this particular case, one can hardly imagine these tracks being made so definitely and preserved so clearly if the bottom were of ooze covered with water. They are more like the imprints left on a mud-flat; and the substance must have had some time to consolidate before it was covered by the next deposit of ooze. The natural conclusion seems, therefore, to be that the animal had been wave-borne, or wind-swept, or even carried by some fishing form, half reptile and half bird, out of its natural habitat, and dropped on a mud-flat exposed for a time to the direct rays of the sun. Why it did not crawl forwards we cannot say; perhaps it had suffered some damage. At any rate, it began to crawl backwards, hoping, if one may so express it, to win again to deeper and cooler water. Unfortunately for itself, but fortunately for us, it was overcome on the way. It is now exhibited in Gallery 8 of the Geological Department, and bears the register number I 16137.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin.

PROFESSOR BARNARD'S OBSERVATIONS OF HALLEY'S COMET.—A most interesting account of Professor Barnard's visual and photographic observations of this famous comet is contained in the *Astrophysical Journal* for June last. He points out that, in addition to the sentimental interest attaching to its long history of two thousand years, it was remarkable for the great apparent length of its tail, 120° or more, which seems to be unsurpassed. This was due to the nearness of the comet to us in May, 1910, since the length in miles was not extraordinary. I am glad to see that Professor Barnard combats the erroneous impression that the late return of the comet ought to be regarded as a disappointment. It is quite true that in northern latitudes its low altitude and the prolonged twilights of May robbed it of much of its splendour; but in this country at least the public were fully forewarned of these unfavourable conditions. The accounts of observers in the tropics or southern hemisphere are of a most enthusiastic character, describing the tail as a magnificent searchlight beam, ascending from the eastern horizon to the zenith, and even further.

I notice that he favours the view that the Earth did actually penetrate a portion of the tail. He notes the presence on 1910, May 17th and 18th, of a lower band, fainter but broader than the main beam, that involved the ecliptic, and was evidently more than long enough to reach the Earth. This was independently seen by Miss Mary Proctor, Professor D. P. Todd, Mr. Innes in the Transvaal, Dr. F. C. Cook and Professor Perrine in the Argentine Republic.

As regards phenomena that might be associated with the passage of the tail, he says: "The forenoon of May 19th developed peculiarities that were very suggestive . . . a peculiar iridescence and unnatural appearance of the clouds near the Sun and a bar of prismatic light on the clouds in the south. The entire sky had a most unnatural and wild look." The abnormal conditions began about noon on the 19th. He refers to similar observations in the Transvaal, etc., and I may add that I myself noticed a remarkable columnar structure of the clouds on the following night at Greenwich. Professor Barnard gives, as a further

effect of our passage through the tail, an account of an appearance of slowly moving steps and masses of self-luminous haze, first seen on the night of June 7th, 1910, and continuing for a year. To these appearances we may add the phenomenon known as "Bishop's ring," which was seen round the Sun, as in 1883, after the Krakatoa eruption. Possibly, also, the widespread thunderstorm which occurred on the night of the passage deserves to be put on record.

The detailed sketches of the nucleus made with the forty-inch refractor show two bright wings with parabolic outlines, pointing one to north, one to south. These are similar to some drawings of the comet made in 1835, and show that the type of a comet may at times persist, in spite of the continual changes going on.

A beautiful series of photographs was obtained with the ten-inch lens, several being reproduced in the article.

The photograph of June 6th, 1910, in combination with those made at Honolulu and Beirut, enabled the acceleration of the tail matter to be measured. In an interval of seven and a half hours the speed of recession from the Sun increased from sixty-four to eighty-six kilometres per second. The recession from the nucleus increased from thirty-seven to sixty kilometres per second.

The receding matter seemed to be a complete discarded tail, having outlines similar to those of the main tail, but rapidly receding from it. A Kodaikanal photograph, taken in April, 1910, showed a similar phenomenon. It is curious that immense jets of tail matter can apparently retain their individuality, and recede more or less as a single entity, in spite of the inconceivable tenuity of their substance.

The comet was observed visually for the first time by Professor Burnham, at Yerkes, on September 15th, 1909. Professor Barnard notes that it was then much brighter than the limit of visibility with the forty-inch, so that it might have been seen earlier but for the unfavourable position in the sky. The last visual observation with the forty-inch was May 23rd, 1911. It was photographed at Flagstaff for a few days longer till June 1st. Professor Lowell has sent me a print illustrating the Flagstaff photographic observation from May 18th to June 1st, 1911 (see Figure 326).

It is interesting to read that many people took the precaution to stop up key-holes and cracks in windows to keep out the deadly comet gases. Professor Barnard thinks that some scientific writers are to blame for having misled the public as to this risk.

STUDIES ON STAR MOTIONS. Professor C. V. L. Charlier has published an essay in the *Meddelanden* of the Lund Observatory, in which he analyses the distribution of the proper motions in the "Preliminary General Catalogue" of Boss. He divides the sky into forty-eight squares, and finds the arrangement of proper motions, as regards direction and magnitude, in each of them. The combined result for the solar apex is:—

	R.A.	N. Dec.
Stars of 4th mag. to 5th mag. ...	267°...	35°
Stars of 5th mag. to 6th mag. ...	273°...	31°

Assuming that the solar speed is twenty kilometres per second (after Campbell), he finds that the average parallax of the stars of magnitude five and a half is 0″·011, and their mean distance twenty-nine and a half siriometers (a term he uses to denote a million astronomical units). Kapteyn had found 0″·016, but his result was based on less complete data.

He then examines the rival theories of "Two Star Streams" versus "The Ellipsoidal Distribution of Velocities" (Schwarzschild), and favours the latter one, showing that it implies that "the mean velocity in the direction of the vertex is about double that at right angles to this direction." He also discusses the theory of Professor Turner that the stars are moving in elongated elliptical orbits about a centre. He finds that he can explain on this theory a certain want of symmetry in the velocity distributions, which would arise in case the Sun were near the centre of motion, but not quite coincident with it. He favours the theory without reaching a definite conclusion about it.

The next question that arises is whether the law that holds in gaseous mixtures (the mean energy being the same for all particles, *i.e.*, the velocity varying inversely as the square root of the mass) holds in the stars of different type. With the aid of results obtained by Kapteyn and Wicksell the following table is arrived at:—

Spectral type.	Absolute mag.	μ = Mass.	$1/\sqrt{\mu}$	Vel. in kms. per sec.	Vel. in units of Type F.
	m.				
B	−2·31	5·21	0·44	6·4	0·44
A	+1·47	1·63	0·78	10·5	0·73
F	+3·07	1·00	1·00	14·4	1·00
G	+3·85	0·79	1·13	15·9	1·10
K	+4·10	0·73	1·17	16·8	1·17
M	+8·17	0·21	2·19	17·1	1·19

It will be seen that the agreement between the fourth and sixth columns is remarkably good, except in the case of M stars. This leads us to conclude that the doctrine of the "equipartition of energy among the stars" is approximately true. The failure in the case of the M stars may perhaps be explained by Professor H. N. Russell's result that these should be divided into two classes—the Giants and the Dwarfs.

Professor Charlier reminds us that the small bodies of the solar system do not exhibit the equipartition of energy. However, their velocities are impressed on them by a single mighty mass—the Sun—and their case is not quite analogous to that of isolated stars that are only under the influence of the combined attraction of the stellar universe.

One noteworthy feature of this important essay is that, though it emanates from Sweden, it is written in English—and very good English, considering that the author is a foreigner. This compliment to our language is paid also by several other numbers of the Lund *Meddelanden*.

THE WAR AND THE SOLAR ECLIPSE.—War leads to many tragedies, but as astronomers we cannot help giving a moment's thought to its lamentable effect on the observation of the eclipse. Many who had planned to observe it are prevented from going at all. Others reached their stations before the outbreak of hostilities, but they are likely to suffer much inconvenience and hardship on their return journey, even if their actual observational work is not interfered with, as it may be, by military exigencies.

Two other cases occur to me where astronomical observations were hampered by war. A French astronomer, Le Gentil, was taken prisoner on his way to observe the transit of Venus of 1761, and was not released till too late. He remained in Asia to observe the transit of 1769, but his desires were frustrated by cloud. M. Jannsen escaped by balloon from the siege of Paris, in December, 1870, to observe the eclipse of the Sun in Algeria.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

PLANKTON (FLAGELLATES AND GREEN ALGAE) OF THE ADRIATIC. (*Continued from page* 306.)—In his second paper Schiller describes new species of Chlamydomonadales (*Pyramimonas*, *Carteria*, *Chlamydomonas*, and *Cymbomonas* nov. gen.), and gives biological

notes on the Flagellata and Chlorophyceae in the Adriatic plankton. These are most abundant in the warm months, June to September, beginning rapidly in February and gradually increasing until they attain their maximum in August with over sixty-seven thousand per litre, after which they rapidly diminish to the winter minimum.

As in the case of the Coccolithophoridae (see preceding notice), these minute components of the phytoplankton swarm in the sea at the warmest period, during which the net-obtained plankton (the larger forms) are scarce, and this gives them great importance as producers of organic substance. Among the Flagellate groups the Chrysomonads, Cryptomonads, and Euglenineae were obtained throughout the year, while the Chloromonads were observed only in February and March, and then but sparingly. As regards horizontal distribution, the northern part of the Adriatic (north of a line drawn from Ortona on the Italian to Sebenico on the Dalmatian coast) is richer in these naked phytoplankton forms than the southern part, and these are particularly abundant in the littoral waters under the influence of the fresh water from the Italian rivers up to twenty or thirty sea miles from the Italian coast. On the Dalmatian side the corresponding zone is much narrower and somewhat poorer in these forms. The conditions are similar in the southern Adriatic, the forms mentioned being here also neritic, but much less abundant. The marked influence of the inflowing fresh waters on the abundance of the Flagellata and Chlorophyceae, and of the phytoplankton in general, is strikingly shown by a comparison between the two shores, the Italian littoral with its numerous rivers, especially the Po, showing a much richer phytoplankton than the Dalmatian coast, with its fewer and less voluminous streams. Comparisons of vertical distribution show that in May the maximum of Flagellata and Chlorophyceae is at twenty metres depth with about twenty-nine thousand individuals per litre, and in August at fifty metres depth with about sixty-two thousand; in August the number of individuals per litre is nearly double that found in the surface water. Since the quantitative increase from the surface to fifty metres depth is very gradual, it may be inferred that the rapidly diminishing temperature from above downwards has very little influence on the vertical distribution of these forms, and that light and probably also salt-content play the chief rôles in its determination. The results obtained give convincing evidence that the minute plankton obtained by centrifuge and filter plays a much more important part than has hitherto been supposed in producing organic substance by their carbon assimilation.

A NEW FRESHWATER "FLORA."—Under the title of "Der Süsswasser Flora" a most important new work is now being published by G. Fischer, of Jena. The work is to be completed in sixteen volumes, of which seven have already appeared, each volume dealing with a group of freshwater plants (including Flagellata); the volumes vary in size and price, but those so far published are remarkably low-priced, considering the abundant illustrations. Each volume is written by a specialist on the group dealt with, and a prospectus may be obtained through booksellers or direct from G. Fischer's Verlagsbuchhandlung, Jena. Of the volumes now obtainable Heft 1 deals with the colourless and Heft 2 with the coloured flagellate groups, which are of such great importance in connection with the evolution of the Algae; Heft 3 with the Peridineae, which some regard as of flagellate nature, and others as being definitely plants; Heft 6 with part of the Green Algae (Ulotrichales, Microsporales, Oedogoniales); Heft 9 with the Zygnemales (Conjugatae, excluding Desmids, which will form a separate volume); Heft 10 with the Diatoms; and Heft 14 with the Mosses and Liverworts. Subsequent volumes will not only complete the Algal groups, but also deal with the Pteridophytes and Seed Plants, and with the Plankton forms. This work is of great importance to British students of aquatic plant life, since very many of our species occur in the area to which this work is devoted—Germany, Austria, and Switzerland. Practically all the figures have been drawn specially for the work, every species being figured, while the general introduction to each volume and the details given regarding the morphology, development, biology, and methods of investigation and preparation make the work interesting and helpful to the amateur as well as a valuable reference book for more advanced students of botany.

PRUSSIC ACID IN PLANTS.—It has been known for some time that various plants, belonging to different families, produce free prussic acid. In these "cyanogenetic" plants the largest amount of this acid is produced by the green leaves and the young parts, while the root gives little or none. Animals rarely touch these plants. Light and the assimilation processes depending upon light exert a favourable influence on cyanogenesis, while the absence of carbon dioxide greatly diminishes the amount produced. According to Jorissen (*Bull. Acad. Roy. Belg.*, 1913), the most recent investigator of the subject, this acid may result not only from the process of carbon assimilation, but also from the action of nitrogen compounds upon substances like vanillin and citric acid. For instance, if a mixture of citric acid with a much smaller amount of potassium nitrite and a trace of bicarbonate of iron be exposed to light in a glass vessel for a day, the latter being open and kept at the ordinary temperature, hydrocyanic acid is formed. Citric acid is widely distributed among plants, and has been shown to be formed at the expense of sugar in cultures of lower fungi. The experiment described appears to represent pretty accurately what actually happens in plant tissues, and it is interesting to note that along with the prussic acid there is formed in the experiment the substance dimethylacetone, which is one of the products of polymerisation or doubling of the glucoside linamarine, also found in plants.

THE ALGAL GENUS *PORPHYRIDIUM*.—In 1849 Nägeli described, under the name *Porphyridium cruentum*, a common alga, which forms a thin slimy substratum of dark-red colour on damp ground, damp walls, and so on. The cells are closely arranged to form a thin gelatinous layer, and are either globular or angular by compression; the layer is several cells deep, the cell-contents are of a reddish purple colour, and cell-division takes place in all directions. The plant was at first placed in the Green Algae (Chlorophyceae), but Hansgirg, and also West ("British Freshwater Algae," page 351), considered it belonged to the Blue-green Algae, West remarking that there are many of the latter which possess as much red or purple pigment as *Porphyridium*, and that this genus is generally found in association with blue-green algae, and being, in his opinion, more nearly allied to *Aphanocapsa* than any other genus of algae. On the other hand, Gaidukov, in 1899, found that the red pigment of *Porphyridium* is very similar to the characteristic pigment (phycoerythrin) of the Red Algae in spectroscopic characters, and he suggested its being placed in the Bangiaceae, the lowest division of this group of algae. The same conclusion was arrived at by Brand in 1908, and adopted by Wille in Engler and Prantl's "Natürliche Pflanzenfamilien." The plant has again been investigated by Kufferath (*Bull. Soc. Roy. Bot. Belg.*, 1913), using the methods of isolation and cultivation employed in bacteriology, which have given such interesting and valuable results with the lower algae, growing the plant on gelatine containing the essential inorganic salts. The algae can assimilate certain organic compounds, of which the most favourable to its development are oxalate of lime, the sugar mannite, citrate of lime, and asparagin. Kufferath shows that the cells have no pyrenoid; what was formerly taken for one is simply an optical effect produced by convergence of the light-rays in the centre of the cell. He agrees with Hansgirg and Brand that from its morphological characters and the nature of the red pigment the genus should be placed

in the lower Red Algae, and has no affinities with either green or blue-green algae.

EVOLUTION OF SIEVE TUBES.—Under this title Hemenway (*Bot. Gaz.*, Vol. 55)) gives the results of the study of the phloëm of one hundred and forty genera of Dicotyledons. He groups sieve tubes in three classes: (1) With a long, tapering end-wall, and the lateral and terminal sieve plates alike; (2) with end-walls less oblique, and the lateral sieve plates less well developed; (3) with end-walls nearly at right angles to the length of the tube, and a single sieve plate on the end-wall. The lists show that the woody Dicotyledons are found in the first of these classes, which is also the type of Conifers, while the herbaceous Dicotyledons occur either in the third class or between the second and third. These facts add to the evidence for the view that herbaceous Dicotyledons have been derived from woody plants. Striking evidence for this view—that trees and shrubs are primitive as compared with herbs among flowering plants—has already been obtained from the study of various other structures, including that of seedlings.

DICOTYLEDONS WITH ONE OR SEVERAL COTYLEDONS.—It has long been known that certain Dicotyledonous plants have a single cotyledon, while others have more than two, and that such cases may occur either normally or as accidental monstrosities. Compton (*Ann. Bot.*, Vol. 27) has investigated a considerable number of these cases, his paper being divided into two parts dealing respectively with Syncotyly (the two cotyledons "fused" into one) and Schizocotyly (the cotyledons "split" so that more than two are present in the embryo). In certain cases (*Swainsonia*, Sunflower, and so on) the anatomy of normal and syncotylous seedlings is compared; in *Swainsonia* the lateral union of the cotyledons produces practically no modification in the vascular bundle system, while in the Sunflower, syncotyly leads to elimination and compression of the bundles, together with reduction in the symmetry of the root-structure. In the case of lesser celandine the author considers the so-called syncotylous seed-leaf to be really a single cotyledon, the second one being suppressed. As to syncotyly in general, he shows that: (1) Syncotyly occurs in a large number of species, normally or teratologically; (2) in species with albuminous seeds syncotyly usually gives rise to a symmetrical cotyledon tube, the reason being probably the homogeneity of the surroundings of the embryo before germination; (3) in species with exalbuminous seeds syncotyly is usually asymmetrical, the cotyledons uniting along one edge only, the asymmetry of the environment producing accumbency and other irregularities as well. The author's main conclusion is that dicotyly is a primitive character, whether for Monocotyledons, for teratological, syncotylous, and schizocotylous Dicotyledons, for polycotylous Proteaceae and Loranthaceae, and for Gymnosperms.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

ESTIMATION OF THE DUST FALL NEAR CEMENT WORKS.—Of recent years the question of the amount of the dust fall in the vicinity of cement works has become very important owing to the legal actions brought by those in the neighbourhood against the manufacturers. The investigation of Mr. J. P. Mitchell (*Journ. Ind. Eng. Chem.*, 1914, VI, 454) of the various methods suggested for the estimation of dust in the atmosphere is therefore of value from many points of view.

Filtration methods, in which a given volume of air is aspirated through a filter, and the deposit of dust subsequently weighed, are not applicable to the purpose in question, which is to measure the amount of dust deposited in a given place. For the latter purpose satisfactory results were obtained by exposing glass plates smeared with vaseline for periods of three to five days at intervals over a length of time, such as three to five weeks. The plates were laid on horizontal platforms at the top of high poles, and care was taken to choose days on which there was little or no wind.

After the exposure the vaseline and adhering dust were removed from the plates by means of petroleum spirit, and the dust collected on a filter, which was then ignited and the residue weighed and expressed as "pounds per acre per day."

The total amount of dust thus collected was composed of the "field dust" blown from the surface of the ground, and normally present in the air, and the "cement dust" from the works. The former usually contained much silica and little calcium, while the latter contained a large amount of calcium salts and relatively little silica. Hence, by estimating the proportions of these ingredients it was possible to calculate with approximate accuracy the amount of "cement dust" deposited upon the plate. The following results are typical of those obtained in the vicinity of a cement works :—

Distance from Works. Miles.	No. of Plates.	Time of Exposure. Days.	Pounds per Acre per Day.	Silica per Cent.	Calcium Oxide per Cent.	Calculated Pounds per Acre per Day. Cement Dust.	Field Dust.
1·2	10	3·69	10·9	17·92	47·95	10·4	0·5
1·7	10	3·69	5·8	19·59	43·19	4·9	0·9
2·2	10	3·77	0·7	31·86	31·09	0·4	0·3

Possible errors, due to cement dust already in the soil, and blown on to the plates, could not be eliminated; but they were minimised by placing the plates at points remote from dusty roads. The effect of gusts of wind upon the deposition of the dust is shown in the following results :—

	Exposure Days.	Pounds per Acre per Day.	Silica per Cent.	Calcium Oxide per Cent.	Calculated Cement Dust per Cent.	Calculated Pounds per Acre per Day. Cement Dust.	Field Dust.
Normal	2·9	6·8	29·9	33·7	65·0	4·4	2·4
Windy	2·9	11·7	45·0	19·2	36·8	4·3	7·4

It would thus appear that the method is capable of estimating the fall of cement dust in excess of the normal fall of "field dust," for, in spite of the interference of the wind, the amounts of the former were practically the same throughout the two periods.

Interesting figures are given to show the dust fall near cement works in comparison with the recorded amounts deposited in great dust storms, the results in each case being stated in pounds per acre per day :—

Date.	Place.	Weight of Dust.
1846	South-eastern France	5·62
1847	Tyrol	17·80
1859	Westphalia	275·0
1862	Salzburg	0·75
1901	(March 9–12) Europe, maximum ...	32·4
	do. do. minimum ...	3·02
1912	California, vicinity of cement works, maximum	22·9
1913	California, vicinity of cement works, minimum	0·42

By suitable modifications of the plant practically the whole of this loss of cement could be eliminated, and it is stated that over fifty tons of dust per day have been recovered from one cement works in a form suitable for making into cement.

PLANTS AND CARBON DIOXIDE.—An interesting discovery has recently been made by Messrs. Klein and Reinau (*Chem. Zeit.*, 1914, XXXVIII, 545), whose experiments have shown that plants do not obtain a full supply of carbon dioxide from the atmosphere. They found that by supplying the plant with a large excess of carbon dioxide its growth was promoted to a pronounced extent. For example, plants grown for seven weeks in air containing 3·5 to 4·5 parts of carbon dioxide per thousand increased in growth from 124 to 238 per cent., as compared with plants grown in an ordinary atmosphere.

Referring to these experiments, Dr. Plaschke points out (*Chem. Zeit.*, 1914, XXXVIII, 801) that the moisture in the layers of soil from which the plant draws its nutriment must play an important part in the process, since it must absorb and retain the carbon dioxide formed in the rotting of the humus substances, and prevent its escape into the atmosphere, and thus being lost to the plant. In like manner, the dew, deposited upon the surface of the ground at night—the period during which plants exhale carbon dioxide—must prevent much of this carbonic acid from being permanently lost to the plant. In the daytime this moisture, impregnated with carbon dioxide, is taken up by the plant again.

In this connection it is of interest to note that these conclusions are contrary to the views expressed by Liebig, who held that the carbon dioxide exhaled by plants at night was derived from the moisture in the soil. This moisture was saturated with carbon dioxide, which, in the absence of sunlight, the plant was unable to assimilate, and therefore exhaled. Hence, in Liebig's opinion, this exhalation of carbon dioxide had no connection with the assimilation processes of the plant, and was due, not to physiological, but to purely mechanical causes. Careful experimental work would be necessary to prove or disprove the correctness of Liebig's mechanical theory.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

LIQUID AIR.—The perfecting of the apparatus for producing liquid air on the commercial scale has resulted in recent years in an increasingly greater amount being produced for the manufacture of nitrogen and oxygen, with the result that these substances have become increasingly cheaper, and new applications have been found for them. In a lecture delivered before the Société des Ingénieurs Civils de France, M. Georges Claude gave some interesting details of the present position of the liquid-air industry, the magnitude of which is indicated by the statement that "Cailletet's fleeting mist is to-day transformed into a fantastic river of liquid air, flowing at the rate of nearly one hundred thousand litres an hour." The air, after liquefaction, is fractionated, in order to separate the more volatile nitrogen from the oxygen. The heat required for vaporisation is supplied by fresh air destined to be liquefied; and to such a pitch of efficiency has the apparatus been brought that in evaporating thirty parts of liquid air more than twenty-nine parts of gaseous air are brought into the liquid state. In speaking of the more recent applications of oxygen, following on its greater cheapness, M. Claude described how thick steel plates can be cut with ease by a fine stream of oxygen playing on the metal, first heated to redness, and the advantages obtained by enriching with oxygen the air-blast in blast-furnace practice. A more novel application of oxygen is its employment in the liquid state as a constituent of an explosive. Lamp-black saturated with liquid oxygen burns slowly when ignited, but explodes violently when detonated by a fulminate primer. The advantages claimed for the new explosive are (1) that as it is prepared immediately before use there are no transport dangers, and (2) in the case of misfires the evaporation of the oxygen causes the unfired cartridge to return quickly to a perfectly harmless state. The employment of the other main constituent of air (nitrogen) in the manufacture of cyanamide, and so on, has been described in a previous note.

SURFACE COMBUSTION.—The principle that the components of explosive gaseous mixtures will combine without flame, and at temperatures below the ignition points, when in contact with incandescent solids has been applied by Professor W. A. Bone and Mr. C. D. McCourt in the design of furnaces for commercial purposes. The success of these furnaces is due to the greatly accelerated rate of combustion produced by the incandescent solid and to the large amount of radiant energy developed, resulting in a very rapid transmission of heat from the seat of combustion to the object to be heated. One form of furnace consists of a porous diaphragm of refractory material through which a homogeneous mixture of gas and air is allowed to flow under slight pressure from a small mixing chamber. The diaphragm is composed of granules of fire-brick, or other material, bound together by suitable means into a coherent block. With such a diaphragm the actual combustion is confined within a very thin layer—one-eighth to one quarter inch only—immediately below the surface, and in no way depends upon the external atmosphere. When once the diaphragm has become incandescent, and the proportion of air and gas supplied to the mixing chamber at the back has been properly adjusted, the surface will maintain its incandescence unimpaired, even in an atmosphere of carbon dioxide. The temperature depends merely on the rate of feeding of the gaseous mixture, and as there is practically no lag in the temperature response, an extremely fine regulation of heat is obtainable. A second process, applicable to all kinds of gaseous or vaporised fuels, consists essentially in injecting, through a suitable orifice, at a speed greater than the velocity of back firing, an explosive mixture of gas (or vapour) and air in their combining proportions into a bed of incandescent, granular, refractory material, which is disposed around or in proximity to the body to be heated. It is claimed that by means of this process much higher temperatures are attainable with a given gas than by the ordinary methods of flame combustion without a regenerative system. For steam raising, the granules of refractory material are packed in steel tubes, which are surrounded by the boiler water. A steam trial of a 110-tube "Bonecourt" boiler gave a ratio of "heat utilised" to "net heat supplied" of 0·927.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

GEOGRAPHICAL RESEARCH.—The summary of the work of the Royal Geographical Society contained in the retiring address of the President, Earl Curzon of Kedleston, makes interesting and suggestive reading. During his three years of office exploration has been pursued with zeal and success. The discovery of the South Pole has removed from the competition the last of the trophies the pursuit of which appeals to the imagination of "the man in the street." Increasing attention will now be devoted by the explorer and the public to work, no less useful and difficult, in the frozen and other regions which has hitherto been less thought of. There are numerous unknown and insufficiently known parts of the globe to provide problems for years to come. "When," as the address runs, "an ex-President of the United States can plunge into the unknown, and return with a river a thousand miles long, so to speak, in his pocket, there is material to satisfy the most jaded appetite." More interesting still, however, is the reference to the need to provide suggestions and guidance in research for those geographers who cannot travel. The subject of geography has of late years received more and more attention in the schools and universities, and there is an increasing number of young men available whose interest and training might be put to account in studying the mass of material collected already. The mass will grow with increasing rapidity, and sooner or later the work of exploration will suffer from want of completeness and coördination in the information available.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

GENETIC CLASSIFICATION OF ROCKS.—A most complete and logical classification of rocks on a genetic basis is given in Professor Grabau's new "Principles of Stratigraphy"—a monumental work in more than one sense, since it runs to one thousand one hundred and eighty-three pages and weighs five and three-quarter pounds.

Professor Grabau does not recognise a primary distinction between igneous, sedimentary, and metamorphic rocks, but treats the whole rock field as falling into two grand divisions—the Endogenetic and the Exogenetic. The Endogenetic rocks are those formed by agents acting from within, that is, by agents intimately associated with the forming rock-mass. They include rocks formed by solidification, precipitation, or extraction of mineral matter from the states of igneous fusion, aqueous solution, or vaporisation. The Exogenetic rocks, on the other hand, are formed by agents acting from without upon already existing rock-matter. They are, in fact, the true clastic rocks, whereas the Endogenetic rocks are the non-clastic.

The Endogenetic rocks are subdivided into (1) Pyrogenic or igneous rocks; (2) Atmogenic rocks, due to precipitation from the atmosphere, *e.g.*, snow and snow-ice; (3) Hydrogenic rocks, due to precipitation from water, and almost wholly of chemical origin, *e.g.*, chemically formed limestones, siliceous sinters, salts, and so on; and (4) Biogenic rocks, due directly to the physiological activities of organisms, *e.g.*, coral limestones, coals, etc.

The Exogenetic rocks are classified primarily by reference to the agents responsible for their present characteristics. The texture, or rather grain-size, and lastly the composition, is then considered. Six principal groups are recognised, as follows:—

(1) Pyroclastic rocks—due to volcanic agencies, *e.g.*, tuff, agglomerate, volcanic breccia.

(2) Autoclastic rocks—including all rocks shattered or crushed within the crust by earth-movements, *e.g.*, fault-breccias and crush-zones. Glacial tills are also included here, since they are regarded as having been ground up between moving ice (treated as a rock) and the rock-floor on which it moves.

(3) Atmoclastic rocks—comprising rocks broken *in situ*, either by chemical or mechanical means, and re-cemented without further reärrangement by wind or water, *e.g.*, talus-breccias, arkoses, and consolidated decomposition products, such as laterite.

(4) Anemoclastic rocks—including the deposits laid by the agency of wind, *e.g.*, dune and desert sands and sandstones, loess, and so on.

(5) Hydroclastic rocks—the water-laid deposits, which include by far the greater number of the commoner types of clastic rocks, conglomerate, sandstone, and shale.

(6) Bioclastic rocks—types which owe their essential characters to the agency of organisms. In this class are included ant-mounds, soil due to earthworms, and such artificial products as bricks, plaster, concrete, and cement, for which man is responsible, and which at the present time form "rocks" of quite appreciable importance. The inclusion of the last group shows the degree of completeness of this classification.

The clastic rocks are also distinguished as *rudytes* (=rubble-rocks) when the grain is larger than that of sand-grains; as *arenytes* (=sand-rocks) when the grain is similar to that of ordinary sandstone; and as *lutytes* (=mud-rocks) when the grain is that of impalpable powder, or rock-flour. The size of grain is directly proportional to the intensity of the agent concerned in the production of the rock.

The composition of clastic rocks is frequently complex, but Professor Grabau gives two dominant types, the siliceous and the calcareous. Terms, such as "argillaceous," "ferruginous," "carbonaceous," are also used in the nomenclature. In describing both texture and composition, it is recognised that the various classes frequently pass one into the other by insensible gradations, and that it may be difficult or impossible correctly to designate certain complex intermediate types.

On the basis of the foregoing classification a nomenclature has been devised, the leading features of which will be seen from a few examples. When the composition is complex, reference to the composition is omitted in the name. For example, a *hydro-rudyte* is a water-laid conglomerate of complex composition; and a loess, the composition of which is generally very complex, is called an *anemo-lutyte*, in reference to its wind-laid character and dust-like grain. A pure quartz conglomerate deposited in water would be called a *hydro-silici-rudyte*; a consolidated dune composed of calcareous fragments of sand-grain size would be called an *anemo-calcarenyte*.

Once the reader gets over the strangeness of these formidable-looking compounds, it is easy to see that they form a very simple and concise description of the rocks to which they are applied, and, therefore, fulfil the purpose of a scientific nomenclature. Since the igneous rocks occupy quite a subordinate position in a logical arrangement of rock-types in general, the above scheme is mainly concerned with what are generally called the sedimentary rocks, and to many geologists it will provide a complete and satisfying classification of these rocks. The metamorphic rocks, according to Professor Graham, are most logically classified along with the rocks from which they have been derived.

METEOROLOGY.

By William Marriott, F.R.Met.Soc.

METEOROLOGICAL CONFERENCE AT EDINBURGH.—It was mentioned in the March number of "Knowledge" that it was proposed to hold a Conference of Observers and Students of Meteorology and Allied Subjects at Edinburgh from September 7th to 12th. The Executive Committee had made all the arrangements for a very interesting and successful gathering, but, owing to the sudden outbreak of war, they have felt obliged to postpone the Conference.

HOLIDAY WEATHER AT SOUTHPORT.—Mr. Joseph Baxendell, the Meteorologist to the Southport Corporation, in his Report for 1913, points out that the fineness of August last year is not a very frequent occurrence. All things considered, July is absolutely the best month of the year for outdoor holiday life at Southport, while both May and June are much drier, and also distinctly calmer and more sunny, than August. The earlier taking of holidays by some of the Lancashire and other towns is therefore very desirable. In any difficulty, September may be considered; in that district it is commonly a more settled month than August. Owing to the interesting and invaluable local daytime sea breezes, all the summer months are cool by day at Southport; but August is perhaps less bracing than any of the others.

ST. SWITHIN'S DAY AND SUBSEQUENT WEATHER.—The most popular of weather sayings is that relating to St. Swithin's Day (July 15th), for if it rain on that day, it is said that "St. Swithin is christening the apples." There is also the old superstition that it will rain more or less for forty days. The popular form of this saying is:—

"St. Swithin's Day if thou dost rain,
For forty days it will remain;
St. Swithin's Day if thou be fair,
For forty days 'twill rain nae mair."

From an examination of the daily records of rainfall in London for the past hundred years, it appears that the average number of rain days (that is, when ·01 inch has been measured) during the forty-day period, July 15th to August 23rd, is 15·7. During the hundred years there have been thirty-two occasions on which rain fell on July 15th (St. Swithin's Day), when the average number of rain days following was 17·3. There were sixty-eight occasions on which no rain fell on July 15th, when the average number of succeeding wet days was 14·9. This shows that on the average, when rain fell on St. Swithin's Day, there were nearly two and a half more wet days during the succeeding forty than there were when fine weather occurred on that day. But there is no foundation for the statement that it will rain for forty days, there being no case during the past hundred years, the nearest approaches being thirty-one

days in 1817, when it was wet, and thirty days in 1848, when it was fine on St. Swithin's Day.

The greatest number of consecutive wet days was nineteen in 1848, when St. Swithin's Day was fine, and the greatest number of consecutive days without rain (dry days) was twenty-seven in 1818.

The curve of mean temperature shows that on the average this is the hottest period of the year, and that fine, warm weather is probable for several weeks. If, however, rain fall for several days about July 15th, it indicates that the normal conditions have been deranged by cyclonic disturbances, and so rainy or broken weather may prevail for some time.

REMARKABLE SANDSTORM AT TULIA, TEXAS.—Mr. L. Mulhall, the U.S. Weather Bureau Observer at Tulia, Texas, reports that on March 18th a strong wind, which raised much dust and sand, was blowing from the west until 4.30 p.m., when it became calm and sultry, with the temperature about eighty-three degrees. The sky at the time was clear, except that a greyish bank of clouds or dust could be seen rising rapidly in the north. As it came nearer, it was found to be composed of several spiral columns, apparently five feet in diameter, and towering vertically upward to a height of three-quarters to one mile from the ground to the apex of the cloud. The phenomenon was beautiful and awe-inspiring beyond description, and the effect was heightened by the rays of the sun reflecting from the storm cloud. It was travelling at the rate of probably forty miles per hour, and about the time it crossed the Paledora Cañon there were two distinct flashes of lightning and two peals of thunder. There was no rain attending the phenomenon. The storm struck Tulia at 6.42 p.m., suddenly enshrouding the town in darkness and covering everything with dust and dirt. Wheat and oats were badly blown away, and several windmills blown down, while at Happy, about fourteen miles north, the Catholic church and several small houses and windmills were wrecked. The oldest inhabitants consider it the worst storm in the last twenty-three years.

MICROSCOPY.

By F. R. M. S.

A RARE FRESHWATER MITE (*Momonia falcipalpis* Halb.).—In the *Annals and Magazine of Natural History* (July, 1906) Mr. J. N. Halbert published a description and figures of a new Hydrachnid of the family Hygrobatidae which was found in Looscaunagh Lough in 1905. Two specimens only were taken, and, so far as I am aware, this was the only time until this year it has ever been found. As it is a mite about which we want to know more, it will perhaps be interesting to give a brief description and figure of it.

In June last Mr. Alabaster, of Plymouth, a gentleman who is gradually working up a list of the Hydracarina of that district, took, in Conn Quarry, a single specimen of this mite, which was new to him. This was sent on to me to identify. Not having seen one before, I had some little trouble with it myself, as the most striking feature of this mite—the peculiar modification of the first leg—was not figured. Mr. Halbert figured only the claw, not the penultimate segment.

The body is egg-shaped, the smaller end being to the front. It is very like *Midea orbiculata* on the dorsal surface, having the sunk line near the margin all round the body. It is about 0·72 millimetre long. Within the sunk line or groove there are two plates in the dorsal surface, the smaller one holding the eyes on the anterior portion of the body. Within the groove are several glands with hairs. The larger plate is decorated very strongly with a bright yellow Malpighian vessel. The actual colour of the skin is a dark-greenish yellow, but the body portion inside is very dark red and black, which makes the only light portion, the Malpighian vessel, stand out in very strong relief. The ventral surface is nearly all covered with the epimera, which runs back nearly to the posterior margin, leaving a bay for the genital area. The legs are about the same as we usually find on the Water Mites, except the front leg, which has the peculiar modification best shown by Figure 327c.

"Mr. Halbert says two fully developed examples of this species were found amongst a thick growth of Callitriche in Looscaunagh Lough, . . . and from the peculiar modification of the first pair of legs there is no doubt that the specimens are males." In nearly all the Water Mites it is in the male only that there is any modification in any of the legs. The females do not show this peculiarity, species of the genus *Megapus* being the exception. So Mr. Halbert may be right in saying his specimens are males for that reason. But the specimen Mr. Alabaster has sent to me also has the modified first leg, and it is a female, being full

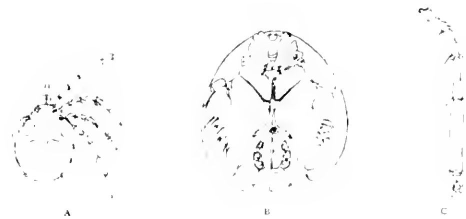


FIGURE 327.

of well-developed eggs. It is partly for this reason that we want to know more about it, and have more specimens to study; and, of course, the larval form and life-history are also unknown to us. Mr. Halbert gives it the specific name *falcipalpis* on account of the shape of the terminal palp-segment. Mr. Alabaster has paid several visits to the pond at Conn Quarry, but no other specimen has come to hand.

The Figure has been drawn from Mr. Alabaster's specimen.

A. Dorsal surface, showing the two plates.
B. Ventral surface.
C. First leg.

CHAS. D. SOAR, F.L.S., F.R.M.S.

THE QUEKETT MICROSCOPICAL CLUB.—The five hundredth Ordinary Meeting of the Club was held on Tuesday, June 23rd, 1914, Dr. E. J. Spitta F.R.M.S (Vice-President), in the Chair. After the usual business of an ordinary meeting, Mr. W. E. Watson Baker read a short paper describing in some detail a series of sections of fossils from the Coal Measures. These were not only rare, but were unique in the distinct manner in which they showed the various structures, both of plants and animals. They were exhibited under a number of microscopes, lent and arranged for the occasion by Messrs. Watson & Son. There were on view also whole specimens, still attached to the blocks of mineral in which they were found. The Chairman commented on the excellence of the exhibit, in conjunction with Mr. Watson Baker's description, and proposed a vote of thanks, which was heartily accorded.

The Honorary Secretary had received congratulatory letters on the Club's attaining its five hundredth ordinary meeting, with wishes for its continued prosperity and increase from Dr. M. C. Cooke, Dr. Karop, Mr. E. M. Nelson, Mr. A. D. Michael, Mr. Alphaeus Smith, and others; portions of these were read to the meeting; and on the motion of the Chairman a letter in reply to that of Dr. Cooke, who was one of the founders of the Club, and would be shortly reaching his ninetieth year, was ordered to be written on behalf of the members.

Dr. Spitta then, in celebration of the occasion, gave a short *résumé* of the history of the Club, with notices of many of those who had been foremost in its origin and work, and recounting various incidents and occurrences in its career. Particular reference was made to Mr. R. T. Lewis, one of

the oldest members, who had been Honorary Reporter since November, 1866, and was still able to carry out the duties of the office. He had attended four hundred and eighty-six out of the five hundred meetings, and the omissions had chiefly taken place only this last winter, owing to illness and advancing years. Mr. Alphaeus Smith, elected in May, 1866, was Hon. Librarian for forty years, but was not now able to attend the meetings. Dr. Karop and Mr. Earland, former Honorary Secretaries, were mentioned, with a kindly reference to the value of their work to the Club. Dr. M. C. Cooke, Mr. J. Terry, Mr. T. H. Powell, and Mr. Millett all joined in 1865, and are still members. Dr. Spitta finished his interesting and delightfully humorous lecture by recounting a supposed reverie (in verse), in which he saw most of the present officers and members coming into a meeting, and detailed with delicate skill and good nature their hobbies and characteristics.

In response to the invitation of the Chairman, several old members who were present then made a few remarks, Messrs. Lewis, Powell, Enock, Earland, and Hilton testifying to their appreciation of and good wishes for the Club.

The Chairman then proposed a rhyming " toast," wishing " Long life to the Club," and at his request the members rose in a body, and with hearty cheers expressed their concurrence with the sentiment. To wind up, Dr. Spitta threw upon the screen a series of lantern views of natural objects nature-coloured. Many of the various flowers and insects were wonderful productions, the colours being beautifully soft and lifelike. At the close, all agreed that it had been a very successful and pleasant evening, and quite in accordance with the best traditions of the Club, which, in the past, on occasion knew how to subordinate the severely scientific to more social methods.

Unfortunately too late to be read at the meeting, a marconigram arrived from the late Honorary Secretary, Mr. W. B. Stokes, at Montreal: " Congratulations five hundredth meeting." (Signed) STOKES.

J. B.

II.—THE COMMON GNAT (*continued from page* 313).—The areas between the nervures have, at regular intervals, short, thick projecting hairs, or processes: these resemble those found on the wing of the House Fly and the Blow Fly (see Figure 328). It is supposed that the hairs act as holders of air, and thus give the insect additional buoyancy. Just behind the point of attachment of the wings with the body, one on each side, are short club-shaped processes known as " halteres " : these are supposed to be remainders of aborted wings.

These halteres, or balancers, as they are sometimes termed, are found in all insects belonging to the great order of Diptera, and in some they are very conspicuous, especially the Crane Fly (*Tipula oleraceae*) (see Figure 329).

The legs and feet of the Gnat are, like the wings, very delicate and beautiful in structure, the length of the legs is very great in proportion to the body, and each leg is made up of long-jointed segments having on each segment clusters of short hairs, very much resembling fins or wings when seen at the edge view (see Figure 330). At the tip of each leg is the foot, which consists of two claws, equal in size, which work on powerful muscles. The claws are unjointed; the familiar pads for adhering to rough or smooth surfaces, found in the House Fly, are absent; and this possibly explains why the Gnat is hardly ever found on window panes.

The insects commonly found during the summer months hanging themselves against our windows and fanlights over doors are very often mistaken for Gnats: they are similar in appearance to the naked eye, but a marked difference can be found in examining how they rest. The insect is known as the Harlequin Fly, or *Chironomus*, and, when resting, the fore legs are held up, not touching the surface upon which the other legs are in contact; whereas the Gnat raises its hind legs in a similar way, while the fore and middle legs touch the surface on which the insect rests.

The process of egg-laying by the Gnat (♀) is worth describing, and, when the period for this function approaches, the insect seeks out some pool, ditch, or some place where stagnant water is contained. The actual details have been so well described by Réaumur, of thermometer fame: " The Gnats supports her body, on the first and second pairs of legs, on some floating object, the third pair of legs or hind legs are then crossed, and in the angle between them the eggs are held as they pass out, one by one, from the tip of the abdomen (see Figure 331).

The whole operation of egg-laying takes place in the early hours of the day, and when complete the mass of eggs is released, forming a raft about a quarter of an inch long, and consists of from two hundred and fifty to three hundred cigar-shaped bodies, glued together, forming a concave-shaped boat. The egg, at its upper end, is pointed; thus a mass of them causes depressions to occur between each egg. When collected in this way, the lower end of the egg is provided with a lid, and through the opening of this lid, when turned back on its hinge, the larvae issue forth into the water when developed. The egg-raft cannot be swamped, and it cannot be made to sink, whatever means are adopted, whilst the eggs are together in a mass. The raft always floats on the surface of the water, and its buoyancy is remarkable.

The fact that the egg-raft never sinks, or is unsinkable, is due to the force of the surface-film of the water and its pull; also, the surface-film cannot penetrate between the eggs. Thus the depressions, or cavities between the eggs are always filled with air-bubbles, and this keeps out the water.

W. HAROLD S. CHEAVIN, F.R.M.S., F.E.S.

PHOTOGRAPHY.

By EDGAR SENIOR.

PYROGALLIC ACID OR " PYROGALLOL."—Although the amidophenols, " rodinal, amidol, and so on," have largely replaced pyro as a developer in the hands of amateurs, more especially in the development of instantaneous exposures, where rapidity is, as a rule, required, it is found that the professional photographer still employs pyro almost exclusively, and only resorts to other developers when speed is a desideratum, or in cases of known under-exposure. This preference is no doubt due to the readiness with which pyro developers may be adjusted to meet the requirements of any particular class of subject or plate, as, according to the amount of alkali used, it can be prepared to work rapidly and softly, or slowly and hard, while density can be increased to a degree which is practically unattainable with the new rapid developers. There can be no doubt that such developers as amidol develop more rapidly, but the action of pyro may be greatly accelerated by the addition of a larger quantity of alkali without risk of fogging the plate to the same extent as would be likely to occur if the same procedure were adopted with some of the other developers. Then, again, pyro can be kept in solution for a length of time by the simple addition of sodium sulphite, while it will still remain active at low temperatures. With these facts before us a short description of the chemical history of pyrogallic acid should not be without interest to those who practise the art of photography. The substance was first prepared by Scheele, the great Swedish chemist, by the action of heat upon gallic acid—a body of which he was also the discoverer. Scheele considered it to be simply sublimed gallic acid; the dissimilarity between the two bodies, however, which was pointed out by Leopold Gmelin and Braconnot, led the French chemist, Pélouze, to study its mode of formation from gallic acid, and to establish its true composition: he pointed out that when gallic acid was heated to 200°C. (392 F.) carbon dioxide was liberated, and a white sublimate

FIGURE 328.

Left Wing of the Gnat (*Culex pipiens*), ♀, showing nervures and processes between them with scales and hairs.

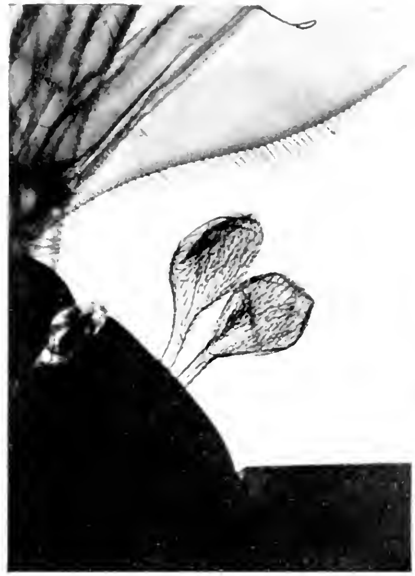


FIGURE 329.

Halteres, or Balancers of the Crane-fly (*Tipula oleracea*).

FIGURE 330.

Leg and Foot of the Gnat, showing fringes of hairs and two claws at the tip.

FIGURE 331.

Eggs of the Gnat which have just been extruded.

FIGURE 332. The "prize mushroom" of Glacier House, a symmetrical snow-cap nine feet in diameter (see "Reviews").

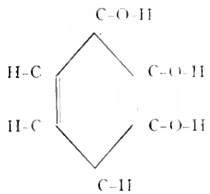
FIGURE [illegible]. Current-mark made during rain by a temporary stream on a sandy road, photographed after the road had dried (see "Reviews").

(From "Waves of Sand and Snow," by Dr. Vaughan Cornish. By the courtesy of Mr. T. Fisher Unwin.)

termed pyrogallic acid formed; a reaction which is expressed by the following equation:

$$\underset{\text{Gallic acid.}}{C_6H_2(OH)_3COOH} = \underset{\text{Pyrogallol.}}{C_6H_3(OH)_3} + \underset{\text{Carbon dioxide.}}{CO_2}$$

Pyrogallic acid is a benzene derivative being known as trihydroxybenzene, and having the following graphic formula.



It is a colourless crystalline substance, readily soluble in water, but if the temperature at which the reaction takes place rises much above 200° C. the substance is converted into a black, shining, non-crystalline mass, known as meta-gallic acid, which is insoluble in water, the change which gives rise to this taking place in accordance with the equation:

$$\underset{\text{Pyrogallol.}}{C_6H_3(OH)_3} = \underset{\text{Meta-gallic acid.}}{C_6H_2(OH)_2} + \underset{\text{Water.}}{H_2O}$$

If the temperature rises sufficiently high, the whole of the pyrogallic acid becomes decomposed. Hence the production of pyrogallic acid is dependent upon a comparatively narrow interval of temperature, which greatly adds to the difficulty of its preparation. This difficulty, however, may be overcome by heating the gallic acid with water to a temperature of 200° C. for about half an hour in a sealed vessel. The solution is then boiled with a little animal charcoal to decolorise it, after which it is evaporated to dryness, and the residue distilled under diminished pressure. By this method very nearly the theoretical yield of pyrogallic acid is obtained. Pyrogallic acid is not, strictly speaking, an acid at all, and its solution is not acid to test-paper, and in all recent works on chemistry it is called pyrogallol, for the same reason that carbolic acid, "whose properties are more those of an alcohol than an acid," is termed phenol. As every photographer is aware, an alkaline solution of pyrogallol rapidly becomes brown on exposure to air, due to absorption of oxygen. Many other substances, such as grape juice, extract of malt, and gum arabic, bring about the oxidation of pyrogallol in aqueous solution, the solution gradually acquiring a port-wine colour, and depositing crystals of a compound known as purpurogallin, having a formula $C_{18}H_{14}O_9$, which resemble alizarin in their appearance and in the colours which are imparted to mordanted fabrics. This compound is also formed by cautiously adding an alcoholic solution of silver nitrate and also by the oxidising action of potassium permanganate:

$$\underset{\text{Pyrogallol.}}{3C_6H_6O_3} + O_2 = \underset{\text{Purpurogallin.}}{C_{18}H_{14}O_9} + 2H_2O$$

The action of a solution of potassium permanganate upon pyrogallol is also of interest as constituting the basis of a method for the volumetric determination of the value of various samples of pyrogallol; as a solution of permanganate of potassium dropped into one of pyrogallol, made acid with sulphuric acid, becomes instantly decolorised. The solution of pyro gradually acquires a port-wine colour, due to the formation of purpurogallin, as shown by the equation; and on the further addition of the permanganate the colour gradually changes to yellow, and finally disappears altogether, due to the complete oxidation of the purpurogallin to carbon dioxide and water:

$$\underset{\text{Purpurogallin.}}{C_{18}H_{14}O_9} + O_{34} = \underset{\text{Carbon dioxide.}}{18CO_2} + \underset{\text{Water}}{7H_2O}$$

It should also be remembered that pyrogallol is poisonous, resembling that of phosphorus in its physiological action, exerting its power by reason of its great affinity for oxygen, which it is able to extract from the blood.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc.

LIGHTNING.—In the issue of *Science* for July 17th, 1914, Prof. Cleveland Abbe appeals for information on this subject. The particular matters upon which further knowledge is sought by the head of the United States Weather Bureau are concerned with the oscillatory character of lightning. After referring to the work of Mayer and others on the subject, Professor Abbe concludes his letter by stating that he hopes "to receive responses from electricians and physicists whose experiments and experience tend to elucidate the subject." Many who read this letter will be struck on reflection by the limited state of our knowledge on the subject. In the elementary text-books various kinds of lightning are described: (1) The normal form, consisting of a spark discharge of electricity, represented by artists as a luminous zigzag line, and whose correct form is now well known through photographs. (2) Sheet lightning, which illuminates large areas without having any definite shape. (3) Summer lightning, which lights up a large portion of the sky at a time. (4) Globular lightning, which consists of moving balls of fire which are said to explode with a loud report. I am inclined to regard (1) as being by far the most usual type of discharge. (2) is said to be caused by brush discharges between clouds, but the appearance of sheet lightning may also be due to scattering of the light of a normal discharge by a cloud which lies in the observer's line of sight. Summer lightning is the general lighting up of a part of the sky, due to the scattering of light from very distant normal discharges. The extremely rare globular lightning is said to have been imitated in the laboratory. I know no one who has ever seen either the natural or the artificial form of globular lightning. It thus appears that the most important part of the problem is the investigation of the normal form of lightning discharge. Although thunderstorms do not occur in this country with excessive frequency, they are still frequent enough to make their study practicable. The subject is one which might very profitably be taken up by the amateur from the observational standpoint.

THE QUANTUM THEORY.—The Physical Society of London has issued a very valuable report, by Professor Jeans, on Radiation and the Quantum Theory. The author is one of the greatest living authorities on mathematical physics, and the report will be welcomed by many experimentalists who have been at a loss whither to turn for a connected account of this theory, which is now being used in several different branches of physics. The central idea of the Quantum theory is that when any form of radiant energy is being given out into space it is thrown out in distinct amounts or quanta, and not continuously. In other words, radiation of heat or light, or x-rays, is not a steady, continuous process, but is one in which the energy is liberated intermittently. The amount of each parcel of energy is, however, capable of variation, but is always proportional to the frequency of the wave-motion which is being radiated; so that if the amount of energy liberated at a time be called W, and the number of complete vibrations a second of the radiation be n, then

$$W = hn \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (i)$$

where h is a constant. This quantity h is not merely constant for the case of the particular thing which is giving out the radiation considered: it is a universal constant of nature, and is the same, no matter what is giving out the radiation, or what is its chemical or physical nature or condition. It is possible to evaluate in figures this quantity h (which is called Planck's Constant), the result being:

$$h = 6{\cdot}6 \times 10^{-27} \text{ ergs} \times \text{sec.} \quad . \quad . \quad . \quad . \quad . \quad . \quad (ii)$$

The real nature and meaning of this constant are not yet known, though some light on the subject may be obtained from very elementary considerations. If equation (1) is true at all, then h must be of the physical nature of energy divided by frequency; that is, it must be of the dimensions of length squared, multiplied by mass and divided by time. These are the dimensions of angular momentum. So that one might regard the fundamental equation of the Quantum theory (equation 1) as suggesting that the angular momenta of the radiating portions of an atom must necessarily have values equal to kh, or an exact multiple of kh, where k is a pure number of no physical dimensions. In my Physics Notes for August I referred to the method of calculation of line spectra by Dr. Bohr. The method can now be more clearly explained. Bohr's assumption is that the angular momentum of the electron in the atom is either $h/2\pi$ or an exact multiple of $h/2\pi$, or that k equals $1/2\pi$.

THE SPECIFIC HEAT OF SOLIDS.—One of the most interesting chapters in Professor Jeans' report is that dealing with recent theoretical and practical work on the specific heat of solids. For most elementary bodies the product of the specific heat and atomic weight is a constant. This statement, which has long been known as Dulong and Petit's Law, becomes more nearly exact as the temperature, at which the specific heat is found, is raised. The constant value of the product (called the atomic heat) becomes 5·95 after certain corrections have been applied to the experimental results. This value is in agreement with that obtained theoretically on the assumption that the atoms behave as mathematical points endowed with inertia. The atomic heat is, however, dependent on the temperature, and only reaches the above value at high temperatures, at lower temperatures it is less. At very low temperatures, indeed, the atomic heat is very small, and when a curve is drawn in which the atomic heat of a substance is plotted against the temperature, the shape of the curve implies that the atomic heat would be zero at the temperature of absolute zero (-273° C.). It is a very remarkable circumstance that the curve is of the same shape for all the elements, and that any one curve (say that for aluminium) can be made to fit on any other (say that for lead) by merely altering the scale of drawing for temperature. In his report, Professor Jeans goes on to explain how this follows from the Quantum theory, but is not in accord with the older and hitherto more orthodox views.

SPECTRUM OF γ-RAYS.—These rays are given out spontaneously by radio-active bodies. They are in general character similar to x-rays, but differ from them in being more penetrating. Since the discovery that crystals will act as diffraction gratings for x-rays, the same method of attack has been applied to the γ-rays. A paper on the spectrum of the penetrating γ-rays from Radium B and Radium C by Professor Sir Ernest Rutherford and Dr. Andrade appears in the *Philosophical Magazine* for August, in which the crystal reflection method is further developed by the measurement of absorption as well as reflection lines. In the course of the work the shortest waves known were measured and found to be $7 \cdot 10^{-8}$ centimetres long. Light in the middle of the visible solar spectrum has a wave-length of $6000 \cdot 10^{-8}$ centimetres, or about nine hundred times as great. This γ-ray, then, is in the ninth octave above that of ordinary yellow light.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

A HARDY WORM.—Casimir Cépède has studied the adaptability of an interesting Polychaete worm, *Nereïs* (*Hediste*) *diversicolor*, which lives in brackish water, in the sea, and in fresh water, and can accommodate itself even to briny conditions. As other naturalists have also pointed out, this Nereïd shows a great power of surviving even sudden changes in salinity.

SEQUENCE OF PLUMAGES IN A MALE TRAGOPAN.—C. W. Beebe, Curator of Birds to the New York Zoölogical Society, has published some very interesting preliminary notes of studies which he has been making on pheasants. Thus, in reference to the male of *Tragopan satyra* he finds the following suggestive sequence of plumages: (*a*) A down plumage of definite regional pattern; (*b*) a juvenile plumage of definitely patterned feathers; (*c*) a first winter's plumage of very generalised female-like coloration and (*d*) the adult plumage exceedingly specialised as to the feathers themselves and as to their distribution, colour, and pattern.

COMPLETE TOOTHLESSNESS OF MYRMECOPHAGIDAE.—It is well known that the members of this edentate family, of which the Great Ant-eater (Myrmecophaga) is a type, show no traces of teeth. This was satisfactorily proved by Röse and by Leche many years ago. It has been suggested, however, that the investigation of young embryos might result in the discovery of vestigial tooth-rudiments. It is interesting, therefore, to notice that Herr Adloff recently sectioned two embryos of the Little Ant-eater (*Cyclothurus didactylus*), six centimetres and twelve centimetres in length, and found no hint of either tooth-germs or a dental ridge. If there are any vestiges they must be in still younger embryos.

INFECTIOUS ALTRUISM.—In his observations on the breeding habits of the white ibis (*Guara alba*), Mr. C. W. Beebe refers to an interesting phenomenon indicated by the title of this note. Both parents take part in incubation and in feeding the young, and the male bird may feed his mate. The food consists of comminuted fish, which is collected in the chin sac. The old bird opens its bill widely when it comes to the nest, and the young ibis reaches up and takes the food from the throat of the parent. "The sight of this feeding process is contagious, and I have seen unmated ibises moved to fly up with offerings of food, and even the young bird of the preceding year makes similar attempts. All are hustled away by the parents, however, before they have even a chance to carry out their altruistic efforts."

ORIENTATION IN SWIMMING CRUSTACEANS.—W. v. Buddenbrock has made a number of ingenious experiments on shrimp-like Crustaceans with reference to their power of adjusting their position in the water. This seems to depend on three reflexes, which are frequently combined. Most important is the reflex associated with the eyes, the animals being thereby bound, if they can, to keep their dorsal surface exposed to the rays of light which normally come from above. Secondly, there is a gravitational reflex associated with the statocysts, the animals being thereby bound, if they can, to keep their ventral surface towards the centre of the earth. There is a third, more mysterious, reflex, which does not seem to be associated with any special sense-organ, but has to do with the general pose of the body.

MILLIPEDE'S NEST. — Mr. Hugh Main has watched the nest-building of a Common Millipede (*Polydesmus complanatus*), which is often found under stones and pieces of wood. The female swallows earth, and passes it out posteriorly, moulding it into a circular wall with the protrusible end of the alimentary canal and the anal flaps. She travels clockwise round the wall, and, after it is raised a little, deposits a layer of eggs within its shelter. Another layer of material is next added to the wall, then another layer of eggs, and so on alternately. As the wall is raised the diameter is reduced. A dome is almost formed, but the top is carried up into a vertical chimney. The whole structure is then disguised with minute pieces of earth, but a small opening shows the top of the chimney. When the eggs hatch the little white six-legged Millipedes climb up the chimney. They are long in assuming the usual dark colour (sometimes not for more than a year) and their full complement of legs.

REVIEWS.

ASTRONOMY.

Collated List of Lunar Formations, named or lettered in the maps of Neison, Schmidt, and Mädler.—Compiled and annotated for the Committee by Miss M. A. BLAGG and the late S. A. SAUNDER. Edited and with an Introduction by Professor H. H. TURNER. 182 pages. $10\frac{1}{2}$-in. × 7-in.

(Oxford: The University Observatory. Price 2s. 6d., postage 3d.)

This work is one produced under the direction of the Lunar Nomenclature Committee of the International Association of Academies. It may be well to recall how this committee came into existence.

The late Mr. S. A. Saunder, for many years the Senior Mathematical Master at Wellington College, drew attention in 1905 to the extremely complex and unsatisfactory state of the nomenclature of the more important lunar formations. In concluding his paper he considered the matter could be satisfactorily solved only by some international committee. The international association of academics, formed in recent years, accepted the proposal when it was brought before that body at the meeting in Vienna in 1907. A lunar nomenclature committee of six was appointed, eventually three others were added, and the work was immediately taken in hand. Though so recently appointed, it is sad to think that all of the six but Dr Weiss and Professor Turner are dead.

Until his death, Saunder was working hard upon this committee and this book, and by the invaluable aid of Miss Blagg in the collation of the List and in reading the proof sheets, the printing and publication have been achieved. But it is doubtful if so much would have been possible had it not been for the courteous help of the French Government, at the recommendation of the Académie des Sciences (Paris), in bearing the cost of the printing, Great Britain and Germany undertaking the cost of the maps. This list marks a decided step forward in lunar work. The list itself is only a preliminary one to that which it is intended or contemplated to publish when the Committee shall have decided upon the names or notation of about five thousand formations. The actual list consists of parallel columns for the names given by Neison, Schmidt, and Beer and Mädler, to which are added columns for the current number and the symbol. The explanation of the List and its collation is given on two pages. Altogether, there are four thousand seven hundred and eighty-nine formations noted on one hundred and sixty-eight pages, followed by ten pages of notes, and concluded with an index of four pages of the proper names. The work can be obtained from Oxford or Messrs. W. Wesley & Son, Essex Street, London.

F. A. B.

CHEMISTRY.

The Whole Art of Dying. 359 pages. $7\frac{1}{2}$-in. × $5\frac{1}{2}$-in.

(Shottery: The Tapestry Studio. Price 3/6.)

In the year 1705 an English translation from the French and German of the methods then used in "dying" silk, linen, and woollen fabrics appeared in London. It was a happy thought of the publishers of this book under consideration to unearth the old treatise, and to issue it in a form in keeping with the old spelling and phraseology.

The methods of dyeing fabrics then in use were purely empirical, but gave excellent results, for they embodied the experience of generations. In fact, many of the processes described here have only been superseded because they were too expensive for the present day.

Among the other subjects dealt with are the choice and cultivation of the plants that produce the dyestuffs, the use of chemicals to fix and brighten the colours, and the methods adopted in France to prevent the adulteration of dyes.

All who practise the craft of hand-loom weaving should welcome this little book, which will show them how to dye, while to chemists who have specialised in this subject it is of historic interest.

C. A. M.

Intermetallic Compounds.—By C. H. DESCH, D.Sc., F.I.C. 116 pages. 9-in. × 6-in.

(Longmans, Green & Co. Price 3/- net.)

There was no subject more in need of a critical survey than the researches that have been made into the nature of the compounds formed between different metals. Hence this is a particularly useful addition to the series of "Monographs on Inorganic and Physical Chemistry," the object of which is to correlate the latest investigations in their particular field and to serve as a reference handbook to workers on the same ground.

Dr. Desch is well known as a writer on metallography, and in the present short monograph we find the critical attitude which ought to be shown by an authority on his subject. The historical part is, perhaps, dealt with somewhat too briefly, though this was possibly inevitable from considerations of space, seeing that the main object of the book is concerned with recent researches.

The subjects dealt with include Thermal Methods, Microscopic Structure, the Physical and Chemical Properties of Intermetallic Compounds, and their Relationship to the Compounds of the Metals with Carbon and Silicon. There is a good index and an excellent bibliography.

C. A. M.

Chemical Calculations. (Advanced Course.)—By H. W. BAUSOR, M.A. 48 pages. 7-in. × 5-in.

(W. B. Clive & Co. Price 1/-.)

This little book will be found of great use to students who are working by themselves for any of the more advanced examinations. The methods of calculations used in quantitative organic analysis, molecular-weight determinations, and thermo-chemistry are clearly explained, and illustrated by typical examples, and after each section problems are set, to be worked out by the student. Tables of logarithms, and other reference tables, are given at the end of the book.

C. A. M.

MEDICINE.

Black's Medical Dictionary.—By JOHN D. CROMBIE, M.A., B.Sc., M.D., etc. 859 pages. 431 illustrations. 12 plates in colour. $5\frac{1}{2}$-in. × $8\frac{1}{2}$-in. 5th edition.

(A. & C. Black. Price 7/6 net.)

This book is evidently intended for the intelligent lay public. No knowledge is assumed, and everything is simply and clearly explained. No attempt is made to make the book sensational, but it is nevertheless easy to read and, above all things, correct. It may be said to be a compendium of the simpler facts of anatomy, physiology, medicine, and surgery; indeed, there is hardly any branch of the subjects, however modern, that is not at least touched upon. Every care has been taken to make the book of real use to those for whom it is written, and thus we find at the beginning two pages of special directions, telling us to what subjects to refer in cases of accidents of all sorts, and instructions where is to be found information regarding sanitation, personal hygiene, illnesses of children, and a host of other details of everyday importance.

Another very useful feature is a series of excellent coloured plates of the rashes peculiar to the commoner infectious diseases of childhood. We most strongly recommend the work to all who require simple, practical information in cases of emergency, for we feel that it would be impossible to collect a more useful series of medical facts in a book of the same size as the one we have before us.

S. H.

MINERALOGY.

Practical Instructions in the Search for, and the Determination of, the Useful Minerals, including the Rare Ores.—By Alexander McLeod. 114 pages. 6¾-in. × 4-in.

(Chapman & Hall. Price 5/6 net.)

This book aims to give very simple and easy means of identifying the useful minerals. Only very crude apparatus and a few inexpensive chemicals are needed. The author has drawn upon the prospecting experience of forty years in the preparation of this small book, and it is consequently packed full of time-saving hints and tips in the discovery and identification of useful minerals. It is shown that certain minerals are easily determinable by such simple means as a match flame, a burning pine sliver, or a live coal. Many tables are given, showing the simple eliminatory tests for various classes of minerals. An especially valuable feature is the prominence given to methods of identifying the rare ores. Recent industrial developments have sometimes made these ores more worth searching for than gold or silver. The author is optimistic in regard to the future of the prospector, as can be seen from the following picturesque quotation: "Who says the prospector's day hath fled? His day is now; and it is merely early morn. And the continents, practically unexplored, especially as far as the rare ores are concerned, invite him to their undiscovered bonanzas." This is an unconventional but thoroughly practical book which can be highly recommended to prospectors and miners.

G. W. T.

ORNITHOLOGY.

The Birds of North Hertfordshire. Being Notes on the Birds of Hitchin and Surrounding District of North Herts, with Table of Dates of Arrival of Summer Migrants since the year 1908.*—By Arthur H. Foster, with frontispiece plate and introduction by W. Bickerton. 32 pages [n.d.]. 8-in. × 5-in.

(Hitchin: Paternoster & Hales. Price 2/-.)

This is a lengthy and most useful contribution to the avifauna of a county which still waits a complete history of its birds, one hundred and ninety-two species being recorded by Dr. Foster. Careful distributional details are given, particularly of the rarer and more interesting species, and the status of most is well and clearly indicated. In his legitimate enthusiasm sometimes the author stretches a point, as when he says that the Bearded Tit is a "very rare visitor indeed," basing this on one old record dating back to 1848. We think, too, that it would have been better to have included the records of "escapes"—the Crane, the African Crowned Crane, and the Canada Goose, also the domesticated Mute Swan—under a separate heading as Introductions.

Considering the non-maritime character of the country, there is a surprisingly long list of water- and sea-birds, such as waders (mostly occurring in passage), Gulls, Geese, and Ducks (visitors). This seems to suggest that a migration fly-line touches on the district. The Stone Curlew still continues to nest in at least one place, and a local photograph of the bird approaching its nest is given as a frontispiece. Of the diving sea-birds a rather unexpected result is stated in the remark that the Little Auk is probably the commonest to be reported. The table of summer migrants covers twenty-three species, and a full index concludes the work.

H. B. W.

(1) *Bulletin of the British Ornithologists' Club.*—Edited by W. R. Ogilvie-Grant. Report on the Immigrations of Summer Residents in the Spring of 1912; also Notes on the Migratory Movements and Records received from Lighthouses and Light-vessels during the Autumn of 1911.—By the Committee Appointed by the British Ornithologists' Club. 335 pages. 19 maps. 8-in. × 5-in.

(Witherby & Co. Price 6/- net.)

(2) *Report on Scottish Ornithology in* 1912, *Including Migration.*—By Leonora Jeffrey Rintoul and Evelyn V. Baxter. *The Scottish Naturalist* Extra Publication. 96 pages. 8-in. × 5-in.

(Edinburgh: Oliver & Boyd. London: Gurney & Jackson. Price 1/6 net.)

(3) *Aberdeen University Bird-migration Inquiry: First Interim Report* (1900–12).—By A. Landsborough Thomson. Reprinted from *The Scottish Naturalist*, July, August, October, and November, 1912; February, April, and June, 1913. 55 pages. 8-in. × 5-in. Privately issued.

The collection of material on the subject of bird migration in Britain proceeds apace, and the three works named above are substantial contributions thereto. The "Bulletin" is the eighth consecutive Annual Report issued by the British Ornithologists' Club, and follows the lines previously laid down. These reports contain a large amount of information, the value of which will be greatly increased when the whole series is summarised and reduced to order. The volume under notice contains details of the immigration movements of thirty-three of our summer visitants, and sketch-maps are given for several of the species. These species are mentioned again under other headings in the Report, and it would be an advantage if cross-references or an index were added. A long series of notes (pages 214–278) on autumn migratory movements is given, and these are perhaps more important than the reports on the arrival of summer birds as dealing with a less-known aspect of the subject.

The Scottish Report is an admirable piece of work, and nothing more thorough and clear has been published. Various phases of the subject are described under separate headings, such as Birds new to Scotland, Uncommon Visitors, Hybrids, Extension of Breeding Range, Food, Habits, and so on; but the bulk of the Report is taken up with notes on the movements of birds (pages 34–91). Some two hundred and four species are briefly dealt with in detail, forming a classified and consecutive record of great value, enhanced by the addition of an index of all the species, thus making each entry throughout the Report immediately accessible. The movements of birds in Scotland are certainly well accounted for in this work, which follows one of a similar character by the same authors for the previous year.

The Aberdeen University Report is more limited in scope, being an account of a piece of research work undertaken by the method of marking birds by ringing, and recording those recovered and satisfactorily identified. The recoveries are enumerated in detail under the separate species, many of the records, however, being so trivial as scarcely to justify publication. Very wisely, no attempt is made to draw conclusions at present, but results of value are anticipated from this well-organised and systematic piece of migrational work when it is completed.

H. B. W.

PHOTOGRAPHY.

Photography in Colours.—By George Lindsay Johnson, M.A., M.D., B.S., F.R.G.S. 235 pages. 13 plates and numerous text illustrations. 7-in. × 5-in.

(George Routledge & Sons. Price 3/6 net.)

This work, which constitutes the second edition of this textbook, has been very carefully revised and brought up to date by the author, and gives a very complete account of the best-known processes of colour photography from both a theoretical and a practical aspect, together with a chapter explaining the latest theories regarding the nature

* 1898 is the correct date, as given in the table.

of light and colour. A short chapter is also devoted to the evolution of colour photography, while in another one the comparison between the eye and a camera and the retina with a colour plate is fully discussed. Then the spectrum sensitiveness of a photographic plate, as compared with the visual effect of the spectrum, is explained. The author then proceeds to describe the various methods which have been devised for obtaining photographs in colour, beginning with the interference method due to Professor Lippmann, and proceeding to the various screen-plate processes, such as the "Joly," "Lumière," "Omnicolore," "Dioptichrome," "The Thames Plate," and the "Paget," which are dependent upon the mixing of coloured lights, a principle which is explained in the following chapter. Chapter VIII is devoted to the practical working of single-colour screen plates, giving an account of the various defects that are likely to be met with, and the remedies for the same. Indoor portraiture by means of flashlight, increasing the sensitiveness of colour-screen plates, and the preparation of light-filters for colour photography also find a place in this chapter. In Chapter IX the various methods which involve the use of two and three plates are dealt with, both theoretically and practically, such as the triple-plate process of Sanger-Shepherd, Mr. E. T. Butler's triple-plate camera, and Ives' "Kromskop." Chapter X is devoted to various methods for obtaining colour prints upon paper, such as tricolour half-tone and collotype printing, Sanger-Shepherd's imbibition process, and Dr. E. König's "Pinatype" process, as well as those in which three-colour carbon tissue is employed. In Chapter XI a very full account is given of the latest method for producing colour-prints upon paper by the "bleach-out" process, employing "Uto" paper and a coloured transparency. The final chapter in the book, "Chapter XII," deals with kinematography in colour by means of coloured lights, giving a description of the apparatus employed in taking the pictures, and the various means in use for afterwards projecting them upon the screen. In the Appendix a short account will be found of various theories of colour-vision; tables giving the exposure for various subjects, with combined and separate colour plates, different developers, and the times of development, intensification, and reduction of autochromes and similar screen plates, and so on. In conclusion, we may say that the book will be found a most useful addition to the library of all interested in the subject of colour photography, and we strongly recommend it to the student who desires to gain a thorough knowledge of the theory and practice of the various processes of colour photography with which it deals.

E. S.

SOCIOLOGY.

Interpretations and Forecasts: A Study of Survivals and Tendencies in Contemporary Society.—By VICTOR BRANFORD, M.A., sometime Honorary Secretary of The Sociological Society. 424 pages. 8½-in. × 5½-in.

(Duckworth & Co. Price 7/6 net.)

This is a clearly written and suggestive book by a staunch disciple of Professor Geddes. It might well have borne as sub-title, "A Plea for the Study and Practical Application of Civics." At times, perhaps, the author's style seems a trifle affected, as though he were striving to say something smart, and the whole book leaves an impression of vagueness. He criticises socialism on the grounds that it shuts its eyes to everything but the economic order of things; but I think the element of vagueness in his own views and suggestions is due to the fact that not sufficient emphasis is laid upon the economic side of social problems. All socialists will agree with Mr. Branford in his distinction between money-wages and real wages—between mere pieces of metal and the things that a careful buyer may obtain in exchange for them. All socialists, too, will entirely agree with Mr. Branford that we need, not only better cities—cities beautiful, well supplied with parks, libraries, theatres, and the other blessings that civic life makes possible—but also the power of entering into these blessings and appreciating them. But what does the city beautiful, with its theatres, libraries, parks, signify to the man who has to labour from early morn to late night in order to earn sufficient to house and feed himself and his family? That is where the economic problem obtrudes itself, and demands solution before all else.

But I do not wish to seem unduly critical of a book that contains much that is interesting to read, and would, I am sure, be profitable to put into practice where profit is measured by spiritual gain. Especially welcome is Mr. Branford's plea for closer union between City and University. All the wealth of learning that the University might deliver to the City for civic betterment remains in this country, at least, undelivered and unused, because of the lack of union between the two. And, of course, all sociologists, of whatever creed, welcome Professor Geddes' system of social surveys, of whose value Mr. Branford is a warm advocate. As in man or machine, so, too, in city, we must know where the evil lies before we can profitably set about curing it. As well, also, as Mr Chesterton has pointed out, we must know what state that is which our cure should aim at. Hence the need, not always recognised, of lofty social and civic ideals.

H. S. REDGROVE.

WAVES.

Waves of Sand and Snow, and the Eddies which make them.—By VAUGHAN CORNISH, D.Sc. 383 pages. 80 plates. 30 figures. 2 maps 9-in. × 6-in.

(T. Fisher Unwin. Price 10/- net.)

Dr. Vaughan Cornish has made the subject of Waves his own, and many are the scientific papers which he has written on the subject. He has already put into readable form his researches on the waves in water, and he has now brought together his observations with regard to those on sand and snow. Dr. Cornish's work has taken him all over the world—to study the waves in the desert sands of Egypt and the ripples in snow in Canada—and it strikes us that, however interesting travel may be, it must become all the more so when there is some definite object for which this primary is undertaken.

The first sand-waves which Dr. Cornish considers are those made by the wind. Incidentally his researches have led him to explain the dust and dirt which accumulate at the foot of the wind-screen of a motor-car. It is possible to look over the top of one of these without feeling the wind in the eyes, the direct current of air being thrown slightly upward. If the hand be held close to the floor, however, a return draught can be felt which brings the rubbish already mentioned. An interesting point with regard to the taxicab is also mentioned by Dr Cornish. When the cab is opened by letting down the back part, an inconvenience is caused by the fact that the front of the cab has not been designed as a wind-screen, and is too high for the purpose, so that the return current of air, instead of striking the back of the vehicle, cuts in over it, blowing in on the back of the passenger's head and neck. All sorts of interesting subjects are introduced, such as snow-mushrooms, which are a little away from the main point of the book. They form on the stumps of trees, which, owing to their hardness, are left to a height of six feet above the ground when the timber is cut for building snow-sheds to protect the trains from avalanches in the Selkirk Mountains west of the Rockies. The tree-stump pedestals had generally a diameter of two feet, and the snow-caps, or mushrooms, were of the nearly uniform diameter of nine feet. An illustration of one of these we have permission to reproduce, and our other picture will serve to show how finely illustrated the book is (see Figures 332 and 333 on page 338). The ridges made by sledges come in for attention, as well as the subject of Mackerel Sky. To those who are interested in the world around them, or who seek an attractive subject for study, we heartily commend this book.

W. M. W.

THE PRESENT POSITION OF THE ATOMIC HYPOTHESIS.

By GERALD HARGRAVE MARTIN, F.C.S.

Physical Science is passing through a period of revolution. Armed with the electrons, her latest and quickest projectiles, Atomics has carried the war far into the provinces of Energetics.

Not only does she claim Electricity for her own, but corpuscular theories of light and heat have been revived, and it has been suggested that time does not flow continuously, as had been supposed, but is discontinuous, and passes on, atom by atom. Sir Oliver Lodge complains that an attempt is being made " to reduce Physics to a sort of glorified Chemistry," while the great anti-atomist, Ostwald, tells us that recent discoveries have raised the atomic hypothesis to the rank of a well-grounded scientific theory.

On the other hand, we find the electrical theory of matter growing in favour, while the chemical elements of which the eternal atoms were composed have limited lives.

We learn that the law of conservation of mass is not strictly true, and the hypothesis of an aether is said to be no longer tenable. The only law of conservation which may be true is the law of the conservation of energy.

Is Atomics absorbing or being absorbed by Energetics ?

Let us glance at the evolution of the ideas of matter, atoms, and energy. All knowledge of the external world is derived, directly or indirectly, through the sense-organs, which are only affected by certain forms of energy : " They respond to energy differences between themselves and their surroundings," said Ostwald.

As Kant taught, of things in themselves we know nothing ; we only know of their existence by the effects they produce on our sense-organs ; hence all direct knowledge of the external world is confined to memories of the sensations of light, heat, touch, sound, taste, and smell.

According to Elliot Smith, smell was the predominant sense of the Ptilocercus-like ancestor of the primates, but in man sight has become the predominant sense. " Seeing is believing," hence the visualising tendency in human nature.

" All intelligent action whatever depends upon the discerning of distinctions among surrounding things," said Spencer, and, as Leibnitz pointed out, a substance is only discovered when it has been shown to differ from all known substances.

As all knowledge is relative, the primary task of practical science consists of the detection and measurement of differences, while theoretical science attempts to classify the differences observed.

Now, in order to measure, it is necessary to adopt a standard, and, moving along the lines of least resistance, man has, whenever possible, used himself as a standard.

People are still measured in feet and thumbs, or inches, and horses in hands, while our ten fingers caused 10 to become the basic number of our arithmetic.

John Locke pointed out that we derive our ideas of duration from the flow of thoughts taking place in the brain, and, according to H. Poincaré, our idea of a space of three dimensions is derived from our muscular sensations. The three axes of space meet in our body, and we carry them about with us.

The terms "hot," "cold," "hard," "soft," "moist," "dry," and so on, also all refer to the human body as standard.

" Man is the measure of all things," said Protagoras, and it is the replacement of the human body by more accurate and constant standards that converts ordinary knowledge into science.

" To find an impersonal method of measurement is to found a science," said Le Dantec.

One of the most striking facts about the human mind is its total lack of originality ; so far, nobody has succeeded in recording any really new and original idea.

New ideas can only be obtained from Nature by observation, and the fundamental ideas of science have been gradually evolved from the anthropomorphic views of primitive man ; new theories are constructed from the fragments of older ones.

Newly observed phenomena can only be explained by comparing them with previously known phenomena, and Ostwald defines an hypothesis as an attempt to explain the less known in terms of the better known.

Since the beginning of civilisation the importance of the unorganised solids to man has steadily increased.

Thus the first two periods are known as the Stone ages, which were followed by the Bronze age, and we are still living in the Iron age.

Clubs, levers, knives, spears, and so on, were the important things for primitive man : they were used to concentrate human energy, and they helped those races which best knew how to make and use them, to become the fittest to survive.

Most unorganised solids change so slowly in comparison with man that they were believed to be

unchanging, and the study of these substances led to the abstraction of the idea of eternal matter.

It was the mechanical properties of solids that especially interested man, and they also supplied science with standards and measuring instruments, so that they became the better known in terms of which the less known had to be explained.

As the only things known to primitive man which could do anything, *i.e.*, bring about any changes, were himself and the other animals, he had no option but to extend this one animal cause to explain all the changes he observed in Nature.

A man who causes many changes is said to be an energetic man, and it is from this idea of human energy that the modern conception of energy has been evolved.

At first animals, trees, stones, and so on, were endowed with human energy and caprice, to account for the changes in Nature; but during the metaphysical stages of science these views were replaced by the idea of centralised forces, and what Soddy terms " the preposterous notion that forces really exist, and are the permanent attributes of masses of matter, molecules, atoms, electricity, and so on." The experimental study of the chemical and physical energies, and their transformations, has led to the modern conception of energy.

During the metaphysical stages of science, men began to busy their minds about the constitution of substances.

Are they infinitely divisible, or is there a limit to their divisibility ? To say that they are infinitely divisible does not help us to understand them, for the mind cannot grasp infinity.

Nature repeatedly suggests an explanation for the constitution of apparently homogeneous solid objects : the flock of sheep on a distant hill, the leaves on a large tree, and the grains of sand on the seashore, all appear as homogeneous solid objects when viewed from a distance. At first sight it does appear highly probable that solids consist of indivisible particles, and this was the conclusion arrived at by Kānada, Democritus, Leucippus, and other early philosophers, who had but very little science upon which to base their conclusions.

" When a theory appears probable, be sure that it is false," said Fontenelle. Now, water, the oils, and so on, were classed apart from the solids, because their mechanical properties are quite different ; how are these liquids constituted ? Although they were classed apart precisely because they are not solids, their constitution had to be explained in terms of the better-known solids ; they were said to be composed of solid atoms, and the constitution of gases met with the same fate.

For atomics, liquids, and gases are solids.

The *raison d'être* of these ancient atoms was to explain the constitution of the apparently unchanging parts of nature, so they were said to be indestructible, indivisible, solid particles, which could form transitory aggregates

These atoms were the product of metaphysical speculations. Nothing was known about them, and they did not really overcome the difficulty of infinity; for if a particle is to be theoretically indivisible, it must be infinitely small, a mere mathematical point.

Alchemy was by its nature essentially an experimental pursuit. The alchemists found that the properties of substances can be changed in the laboratory ; thus all substances are more or less affected by heat.

With the aid of the mineral acids the alchemist could transform even that most noble metal, gold, into a transparent liquid. What a wonderful transformation !

Bright liquid mercury, heated with a little yellow volatile sulphur, became transformed into an intensely black brittle mass. What an extraordinary change !

If man can bring about these astonishing changes in the laboratory, why should he not be able to alter the properties of lead, or silver, just a little, so as to make them identical with those of gold ?

If he did, he would have transformed them into gold, for substances are only known by their properties.

This was quite a logical view to take, and it harmonised with the doctrine of principles, or metaphysical elements of Empedocles and Aristotle ; so it put atomics in the background.

These peripatetic elements, hotness, coldness, dryness, and moistness, which were carried by one original matter, were not really four distinct principles, but only two, referring to the temperature of the body and the moistness of the skin as standards.

Owing to the materialising tendency in human nature, the metaphysical elements of the earlier alchemists became transformed into ponderable elements ; thus the metaphysical mercury and sulphur of Geber became materialised into quicksilver and brimstone, and the properties of substances were attributed to their material composition.

With the revival of learning, atomics again came to the front. According to H. Poincaré, it was astronomy which first taught men that there are laws in nature, and astronomy, mechanics, and geometry were the first sciences to make any considerable progress ; so they supplied the better-known, in terms of which the less-known phenomena of the more backward sciences had to be explained.

Although chemical energy is obviously a non-mechanical form of energy, chemical phenomena had to be explained in terms of the better-known mechanics.

At first it was by the falling together of like atoms that all things were made, then it was unlike atoms which united, and they developed points, cavities, little hooks, and electrical poles with which to combine.

By definition an atom is that which cannot be divided ; hence, logically, it cannot have any

parts, for if it had it could be divided into these parts.

Most chemists have been pragmatists: they judged their hypotheses according to their classificatory value, rather than by logic.

Thus the chemical properties of substances were ascribed to statical atoms, and the physical properties to dynamical atoms; nor did chemists hesitate to write about atoms of compound substances; until experiment drove them to the more logical idea of molecules.

Modern chemistry is based upon the stoichiometrical laws, but, as Ostwald observes, although science possessed the atomic hypothesis for over two thousand years, nobody deduced a single stoichiometrical law from it; such laws were discovered in the laboratory.

The modern so-called atomic weights are relative values, selected from the combining weights of the elements, and their electro-chemical equivalents, which are obviously energy constants.

The choice was determined chiefly by the specific heat of the elements, the periodic law, and the volume energy of substances in the gaseous state at normal temperature and pressure; hence these modern atomic weights are purely energetic constants, and are independent of the atomic hypotheses.

In the early days of organic chemistry, chemists had no energetic data to guide them in their choice of the atomic weights of carbon, hydrogen, nitrogen, and oxygen, so here the atomic hypothesis had to rest on its own merits.

This it did, and introduced such a hideous state of confusion that both Liebig and Dumas advised chemists to drop it altogether, and turn it out of the science.

So the chemists replaced their atomic weights by Gmelin's equivalents. While the atomic hypothesis was in disgrace, the theories of types arose, from which the modern graphic formulae have been evolved.

These formulae supply the discontinuity and immobility necessary for the formation of a clear mental image: they are designed so that as many of the properties of the substance as possible are indicated by convention.

They constitute a classification by properties; it is the properties which define the formula, and not the formula that determines the properties.

As Duhem has clearly shown, there is really no question of a mechanical constitution of compounds.

It is the human mind which demands a mechanical explanation, or mental image, and not the compound that demands a mechanical constitution.

The physicists evolved hypotheses of dynamical atoms; true, each dynamical atom was a *perpetuum mobile*, or that which cannot exist, but for atomics this was a detail.

This strange dead, fossil world of inert matter was composed of absolutely hard, absolutely elastic, absolutely indestructible, absolutely frictionless atoms, which were kept in eternal motion by mysterious centralised forces in an infinitely rarefied, frictionless, all-pervading aether, which was much more rigid than steel, and millions of times denser than lead. The duty of the aether was to overcome the difficulty of action at a distance, but in this it was unsuccessful, for its "smallest parts" had to be in a violent state of rotational motion to explain its rigidity; hence it could not be continuous itself; it had to be materialised and atomised to give a mental image.

Dynamical atomics was based on celestial mechanics, but the motions of the stars are not eternal: tidal friction acts slowly, but none the less surely, as a brake.

It was only the brevity of human life that caused the motions of celestial objects to appear to be eternal, just as it caused the chemical elements and the biological species to appear to be immutable.

If all phenomena are due to the mechanical motions of frictionless atoms, all changes, and therefore also physical time, should be reversible.

Thanks to the law of the conservation of energy, a given quantity of any measurable energy can be translated on paper into terms of little particles of mass (m), moving with velocity (v); but this is merely a matter of arbitrary units.

The atomic hypotheses reduced chemical theory to what Ostwald described as a "strange, contradictory conglomerate of the fossil constituents of all former theories," but they were so far removed from the facts that they had but little or no influence upon laboratory methods.

Chemistry remained an essentially inductive science, and the chemist still relies upon his chemical instinct to guide him in research.

Atomics attempted to eliminate time from chemical theory, yet it is only changes that are cognisable, and change is the author of time; hence questions of time underlie the whole of practical chemistry.

The phase rule gave chemists a practical chemistry in space, and the most crying want of modern chemistry is a chemistry in time, to bring theory into closer touch with practice.

The atomic hypothesis gave no foresight; none of the great advances in chemistry were deduced from it, but after the advances had been made, it was rather a question of bolstering it up with supplementary hypotheses, to try to give it some semblance of covering the new facts. Witness the hypotheses of electrical poles, atoms of aether, vacua in the aether, vortex rings, constant, variable, fixed, movable, bendable, positive, negative, neutral, partial, normal, contra, and constantly varying valencies, and so on. Nor can it be said that atomics explained either the physical or the chemical properties of substances.

The idea of two atoms of oxygen united to one atom of carbon no more explains why carbon dioxide is a colourless, somewhat soluble, and reäctive gas than the idea of two atoms of oxygen united to one atom of silicon explains why silica

FIGURE 335. The White Rhinoceros.

(From *Wild Life*, Volume IV. Number 4. By the courtesy of The Wild Life Publishing Company.)

is a hard, crystalline, difficultly fusible, inert solid.

According to atomics the properties of a compound should be the sum of the properties of its constituent atoms, but chemical changes were classed apart from physical changes, precisely because, in those reäctions which first forced themselves upon the notice of chemists, the properties of the reäcting substances became fundamentally altered. One by one, experiment has transferred all the properties of substances, from eternal matter and its atoms, to the energies.

Take, for example, such a familiar element as iron. What are the properties of iron atoms? What properties does iron possess in the solid, liquid, and gaseous states, and in all its compounds?

Even mass has passed from atomics to energetics, and modern science has reduced matter to an absolutely property-less substance, which, as Ostwald remarks, is a thing unthinkable.

But the idea of atoms has survived the matter whose constitution it was born to explain; it has survived the eternal atoms to which it gave birth; it has become ingrained in the scientific mind.

To Newton atoms were solid, massy, hard, impenetrable, indivisible portions of eternal matter.

The modern atom is not indivisible, nor is it indestructible; it is not composed of matter, but of electrons, *i.e.*, of energy; it has a limited life, is compressible, and disintegrates spontaneously.

Now, what conception could possibly be further removed from the eternal, indivisible atoms of Newton, Berzelius, and Clerk-Maxwell than this?

The word "atom" means that which cannot be cut, or divided. "A particle of matter so minute as to admit of no division," said Webster; hence a complex atom is a contradiction of terms.

We must own that atoms are dead: these energy complexes are only their ghosts; indeed, no clear mental image can be formed of an electron, for you cannot picture electricity; yet the study of this form of energy has given us a most useful, practical, and exact science. When the mental picture-book of an infant science gives way to accurate measurements, the science becomes amenable to mathematics, and begins to pass into the all-embracing science of energetics.

Perhaps the great victories which atomics has recently claimed are only word-victories after all; the ideas of energetics have replaced those of atomics, but the atomic language remains.

WILD LIFE.

MR. DOUGLAS ENGLISH, the Editor of *Wild Life*, is greatly to be congratulated on the progress of his Magazine, the variety of the subjects which it includes, and the striking character of the photographs reproduced. The July and August numbers, which are now before us, are particularly good. In the first, Mr. Fred Russell Roberts begins a series of notes on African Big Game with a consideration of the Elephant, which he illustrates with a number of remarkable pictures taken by himself with a reflex camera. One of these we are kindly permitted to reproduce on page 347. Others show quite large herds of the animals, or characteristic attitudes, such as when they are suspicious of man's presence, and with uplifted trunks are "feeling the wind for him."

The same number contains two excellent photographs of young tawny Owls, by Mr. Alfred Taylor, and an article on the Dartford Warbler, specially illustrated by Messrs. Douglas English and C. W. R. Knight. Birds are further considered in a contribution on the Pied Flycatcher; Mammals are represented by an article on the Noctule; while a specially interesting paper is concerned with the nidification of the Stickleback.

In the August issue the account of the African Elephant is concluded, and further pictures given, including a specially good one of a herd of Elephants, with young calves, which have just crossed a river. Mr. Russell Roberts goes on to deal in a similar fashion with the White Rhinoceros. Of this animal we have also been allowed to give a picture (see page 348). Two well-illustrated articles deal with Herons and their allies, while Insects come in for attention.

Both the numbers contain an editorial, illustrated notes on the Zoölogical Gardens, reviews, and correspondence.

It is a pity that, just when this successful point has been reached, the war should intervene to hinder matters: paper is scarce, and, more important, both the Editor and the Sub-Editor have military duties to perform. The difficulty of carrying on the Magazine for the time being will, however, be got over by preparing several numbers containing less matter than usual; but as it is of special merit the subscribers will no doubt be pleased, and will admire the plucky endeavour to keep *Wild Life* going.

NOTICES.

THE NATIONAL RELIEF FUND.—We have the greatest possible pleasure in calling the attention of our readers to the National Relief Fund, most happily and successfully inaugurated by H.R.H. the Prince of Wales. To very many the effects of the war will be most disastrous: those who do not feel the pinch of poverty may well express their gratitude by sending a subscription for the benefit of their less-fortunate own countrymen. A coupon appears in our advertisement pages, and this can be sent, with a contribution, to H.R.H. the Prince of Wales, Buckingham Palace, London, in an envelope, which need not be stamped.

THE ROYAL MICROSCOPICAL SOCIETY.—The meeting on October 21st will take the form of a Conversazione at King's College, Strand.

SECOND-HAND BOOKS.—We have received from Messrs. John Wheldon & Company a clearance catalogue of second-hand books, which contains many dealing with Natural History, as well as sets and series of scientific periodicals.

CLASSES IN PHOTOGRAPHY.—We are asked to announce that Mr. Edgar Senior's classes in Photography begin at the Battersea Polytechnic on Tuesday, September 29th, at 7.30 p.m., and at the South Western Polytechnic, Manresa Road, Chelsea, on Monday, September 21st, at 7.30 p.m. Full particulars as to the courses may be obtained on application to the Secretary in each case.

A NEW BOOK ON BRITISH BIRDS.—Among other interesting items in Messrs. Longmans' "List of Announcements and New Books" is a new book on British Birds, written and illustrated by Mr. Archibald Thorburn. It will consist of four volumes, with eighty plates in colour showing over four hundred species. The first volume, it is hoped, will be issued in the autumn of 1914, volumes ii and iii in 1915, and volume iv in 1916.

THE NATURALIST.—The September number of *The Naturalist* is as interesting as usual. The notes and comments and news given in short and pithy paragraphs form a particularly useful feature of the publication, and two of the important papers in the current issue are "The Early History of Filey," by T. Sheppard, and the continued notes on new and critical British species of mites belonging to the Oribatidae, by the Rev. J. E. Hull.

THE ROYAL PHOTOGRAPHIC SOCIETY'S EXHIBITION.—A feature of the fifty-ninth Annual Exhibition is a striking collection of photographs by the most eminent American workers. Men of all schools have supported the Society, and it is announced that no important departure in treatment is omitted, while the scientific and technical section is crowded. The Exhibition will be open from August 24th to October 3rd, and the Society will give sixpence out of every shilling paid for admission to the Prince of Wales's Fund.

PETROLOGICAL MICROSCOPES.—We have received from Messrs. James Swift & Son a catalogue of petrological and metallurgical microscopes, which claims to be the most comprehensive one yet issued from any source with regard to such instruments and other apparatus required in mineralogical and metallurgical laboratories. Two pages are occupied with a detailed description of Dr. A. Hutchinson's Universal Goniometer, which has never previously been put upon the market. Besides fulfilling the purposes for which it was designed, namely, the examination of small crystals and the usual crystallographic and optical determinations, the instrument lends itself readily to the exigencies of experimental work. A special pamphlet going into greater detail will be sent by Messrs. Swift gratis on request. The crystal refractometer, also described, is made for the first time outside Germany, where its construction has been attempted by only two firms. In the opinion of Dr. H. H. Thomas, of the Geological Survey, Messrs. Swift's model is better designed and more massively built than the Continental form. Other new instruments are the crystal-grinding apparatus and a large microscope for measuring and screw testing. Messrs. Swift & Son are to be congratulated on their enterprise.

REVUE PRATIQUE DE RADIUMTHÉRAPIE: RAYONNEMENTS, ÉMANATIONS, SUBSTANCES RADIOACTIVES DIVERSES ET ARCHIVES GÉNÉRALES DE THÉRAPEUTIQUE PHYSIQUE RÉUNIES.—Appearing under the editorship of Dr. Paul Giraud and Dr. Henri Coutard, in collaboration with M. Gaston Danne, of the Gif Laboratory, the scope of this journal is even wider than its title suggests. Besides containing original articles and abstracts of papers published elsewhere on the purely therapeutical side, provision is made for the inclusion of papers dealing with the results of laboratory work. We may cite, for instance, the article by Professor Wassermann upon the action of radio-active substances upon cancer in mice. We can but welcome such inclusions as tending to foster the interest of clinicians in the work of the laboratory.

Besides these general features, notice should be made of a valuable bibliographical index accompanying each volume. This contains references to original articles in the current literature dealing with practically every aspect of radium-therapy.

We regret having to record an error and an omission occurring in the first volume. The discovery of radium emanation is attributed to M. Curie, whereas it was made by Dorn in 1900. In the list of Radio-active Substances on page 38 we find no mention of gamma radiation as being emitted by them.

The *Revue* promises to be of real service to a growing number of people interested in the part that radio-active bodies may play in matters biological.

G. K.

OPTICAL GLASS AND THE WAR.—That the wonderful progress which has been made in the perfecting of optical systems has been due to the large variety of suitable glasses that have been produced by Schott & Gen, of Jena, is undeniable.

For the time being supplies of this glass are unobtainable in this country, yet the production of optical instruments must continue. Never have British makers of prism binocular glasses been so pressed for supplies, for a great portion of their material has come from Schott in the past.

We are glad to find on enquiry, however, that Chance Bros., whose reputation for optical glass is old and widely spread, have been able to supply what is needed, and that the glasses are being produced without diminution in optical effect and quality.

For microscope objectives most of the makers have a sufficiency of German glass; the amount that is used in each lens is exceedingly small; and as each fresh supply of glass may necessitate a modification of the computation, a substantial quantity is usually taken at one time. We may therefore hope that our makers will continue their usual quality of lenses, and that influences may be working which will cause the production of suitable glasses for the manufacture of objectives from British material.

The output of strictly scientific optical instruments in this country is small in comparison with that of the big Continental sources, and it is doubtful whether any commercial undertaking could profitably manufacture optical glass for this special purpose; but it seems to us that the makers of micro-objectives could quite well afford to pay a substantial addition to the usual rates for this particular material, because the small pieces that are used could not in any way add substantially to the total cost.

The house of Parra Mantois in Paris has been a source of supply of optical glass for many years in this country, and it can undoubtedly be of material assistance in the future. The glass of this house, and that of Messrs. Chance Bros., could in many instances be complementary, and enable many of the present, or equally effective, systems to be supplied.

We are not overlooking modern photographic lenses in our remarks, nor the astronomical telescope. It is true that the former have been dependent on Schott's glass, but the glass for the latter can be satisfactorily supplied in this country.

A big strain is being borne by our opticians at the present time in the recomputing of their systems for the new glasses that they are compelled to use, and the making of tools for the curves determined; but, from the information we have gleaned, it is evident that the workers who entrust themselves to them for their supplies will not be disappointed.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

OCTOBER, 1914.

STEREOSCOPIC DRAWING.

By CHARLES E. BENHAM.

If a test were required for the accurate workmanship of a student in mechanical drawing, no better one could be devised than to set him the task of representing an object in perspective as seen by the right and left eye respectively. The two drawings, when placed in the stereoscope, should show a perfect effect of solidity; but the slightest deviation from exactness in either drawing would manifest itself in the stereoscope very distinctly, and there are few amateurs whose first attempt would not be a failure.

By care and practice, however, very good results may be obtained; and for many scientific diagrams, in which a three-dimensional representation is necessary, stereograms are very useful, and may be substituted with advantage for clumsy models. As examples may be mentioned the forms of crystals, the imaginary planes that have to be explained to students of perspective, the diagrams required to illustrate the polarisation of light, reflection, refraction, and other branches of optics, or, for speculative students, the mysteries of the hypercube.

A difficulty occurs in the limited field allowed by the refracting stereoscope. This necessitates rather small drawing, and, as the lenses of the instrument magnify, the smallest errors are unpleasantly enlarged. Moreover, to avoid distortion, it is desirable that a perspective drawing should come within a horizontal angle of sixty degrees, and a vertical angle of not more than forty-five degrees, which, again, seriously limits the scope of the drawing.

It would be better undoubtedly to construct a special stereoscope with plane prisms allowing of an extensive distant unmagnified field; and, though such an instrument would have to be rather a bulky affair, it would answer the purpose much better for the exhibition of hand-work, and would enable the draughtsman to make his drawings on a less diminutive scale.

Another way is to draw large and reduce by photography to stereoscopic dimensions. With intricate diagrams this is much the best way, and very beautiful results can be produced.

The red-and-green-spectacle method of stereoscopic representation is another way out of the difficulty. The two drawings, which may then be of any size, are drawn (almost superposed), the one in green ink, the other in red. Two gelatine films, stained respectively with the same red and green inks, are used for the spectacles, and the figure is seen like a solid wire model in front of the paper. The process, however, is imperfect. With the red gelatine complete extinction of the red lines is easily obtained, but the green lines always show faintly through the green film, unless the dye is so dense as to obscure vision, or unless the colour-screen is a liquid one, which is obviously inconvenient, though extremely perfect in its effects.

The actual method of drawing for the stereoscope is very simple, extreme accuracy being the main essential of success.

Bearing in mind the prescribed limitations of size and angle of vision to which reference has already been made, the object is first drawn in perspective in the ordinary way. Take, as a simple illustration, a cube. The perspective representation is drawn as on the left in Figure 336. Pencil lines are drawn horizontally from each determining point of the figure, as shown by the dotted lines in the illustration. These are guides for the position of the corresponding points in the right-hand figure. By this means no measuring point is required for the second drawing, as it is obvious that all these corresponding points must lie in a horizontal line with those of the first figure. The right-hand drawing is placed two and a half inches to the right on the picture-plane, the point of sight being moved an additional half-inch, that is, three inches to the right of the original point of sight.

The limits of stereoscopic separation range between two and a half inches and nearly three inches, so that if the vanishing points are separated by three inches, and the nearest points of the drawing by two and a half inches, the whole picture will be seen comfortably without strain. Even a separation of three inches is too wide for some people; but, as the vanishing points themselves do not figure in the finished drawing, it is safe to give them that amount of separation; for probably no part of the actual drawings will be more than about two and three-quarter inches apart.

It will be seen from Figure 336 that by drawing the receding lines to the new vanishing point for the right-hand figure they will be measured off by the horizontal lines. If an angular or oblique vanishing point enters into the left-hand drawing, it must similarly be moved on three inches for the right-hand drawing.

Accuracy is best ensured by pricking the paper with a fine needle at each determining point that is established, and then drawing to these needle-pricks.

Having completed the drawing in pencil, test it, without removing the construction lines, by examination in the stereoscope. If it is true, the whole may then be carefully ruled in with ink. If the stereoscope reveals faults, the lines should be carefully revised and corrected in pencil until they are right.

It is a good plan, instead of inking over the original, to mount it, when all the determining points are quite accurately placed, over a piece of blank paper on a drawing-board, and with a fine needle, mounted in a handle, prick through all the holes, so as to stencil the whole key to the diagram on the lower sheet. Two sheets or more at a time may thus be stencilled, taking great care that the needle-holes are made absolutely vertically. Join up the points on the stencils in ink with a ruling pen, and each will give a complete stereogram.

If the work of preparing the drawings is considered too tedious and troublesome, the services of a professional draughtsman may be engaged; and, by providing him with plan and elevation, and such instructions as are given above, he will produce results much more perfect than those to which the unpractised amateur can attain without repeated trials and failures. Figures 340–343 accompanying this article were drawn in this way by Mr. Duncan W. Clark, A.R.I.B.A., of Colchester, and are good examples of professional accuracy.

Figures 337–339 are specimens of an instructive series illustrating principles of perspective.

Figure 340 represents the principle of the rainbow, and makes it clear how the refracted rays from all parts of any colour band all form the same angle with a line from the Sun to the spectator; a fact which is often puzzling to students.

Figures 341 and 342 represent respectively the law of inverse squares and the principle of the pinhole camera.

Figure 343 is a diagram to illustrate the laws of reflection of elastic bodies.

Figures 344 and 345 are from a series of polarisation diagrams, and show special cases in which the stereoscopic method takes the place of models.

METEORS.

By W. F. DENNING.

ON Sunday night, August 16th, the sky cleared beautifully, and the stars shone with exceptional lustre.

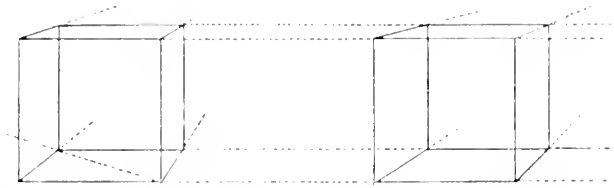
Meteors were rather frequent, and I observed two very definite and distinct showers in activity, viz., one formed of late Perseids with a radiant at $56° + 59°$, and another of Lyrids with a radiant at $279° + 45°$, a few degrees north of Vega. Eight meteors sprang from each of these points.

The Lyrids were also active on August 12th: they are usually swift, bluish-white meteors, rather difficult to record accurately, but often very brilliant and conspicuous.

A bright attractive meteor fell from this radiant at 11.58 on August 16th, with a very slow apparent motion. It descended vertically to my eastern horizon, and I have very rarely traced a meteor so low. It must have been moving from west to east, and probably passed over the region of Ostend, Belgium. The nucleus threw off flakes of fire, and it probably formed a grand spectacle as observed from the North Sea and eastern counties of England. The meteor was also observed by M. E. I. Gheury from Eltham Park, and he says it descended vertically to his eastern horizon, where it burst. From a calculation I have made I believe the meteor must have been less than twelve miles high when it disappeared somewhere about twenty-five miles north of Ostend.

Many brilliant Perseids were observed on the nights from August 10th to 14th. The best were on August 12th, 8h 50m and 10h 33m, and August 14th at 9h 34m. A fireball from a radiant in the north-western region of Aquila appeared on August 14th, 9h 50m. It passed over the north coast of France, near Boulogne, and fell from a height of sixty-seven to forty-four miles, with a velocity of sixteen miles per second.

BRISTOL.



[illegible] Showing method of stereoscopic drawing. The dotted lines represent the pencilled construction lines.

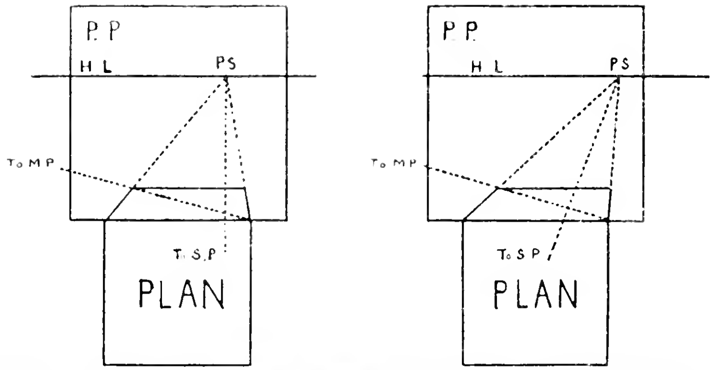


FIGURE [illegible]. The left-hand figure [illegible] the [illegible] perspective paper [illegible] in the text books. How the diagram should be thought out by the student is revealed by the stereoscopic view.

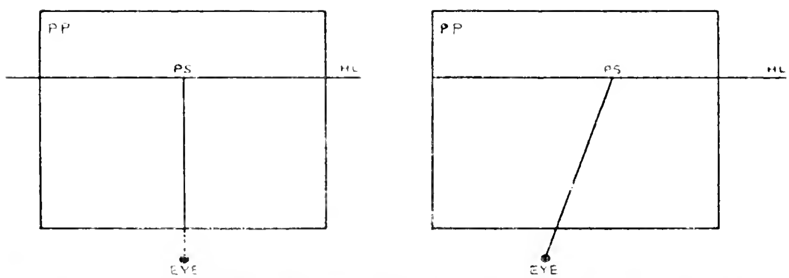


FIGURE [illegible]. Another perspective [illegible] the relative positions in which the horizon line picture plane and station point ought to be regarded.

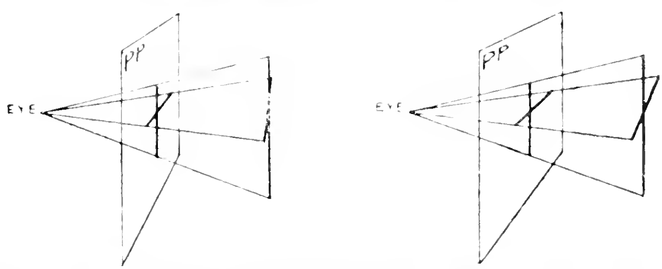


FIGURE [illegible]. Diagram [illegible] lines drawn from all points of the object to the eye.

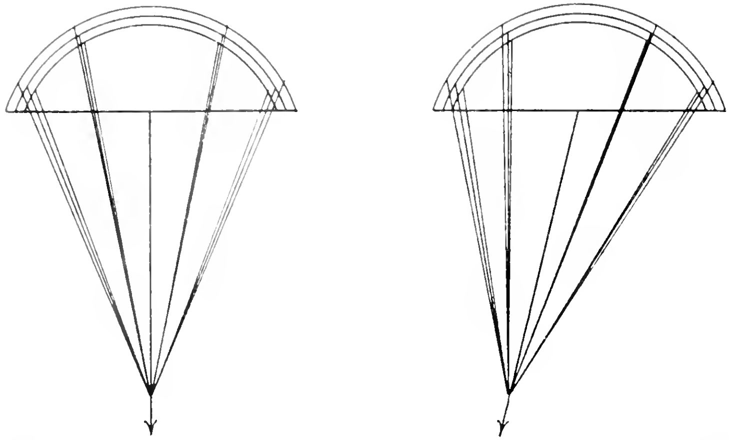


FIGURE 340. The rainbow. A line is shown which if produced would pass through the spectator to the Sun. It will be seen in the stereoscope how the refracted rays form an angle with this line on all sides. The original of this diagram is in colours, making it all the more instructive.

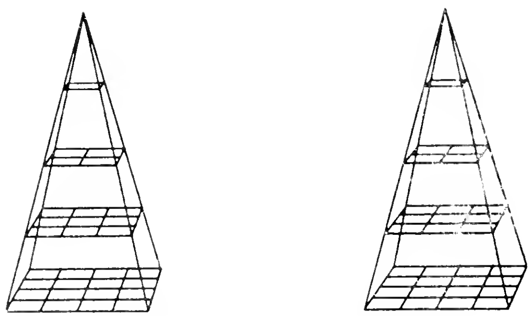


FIGURE 341. The law of inverse squares.

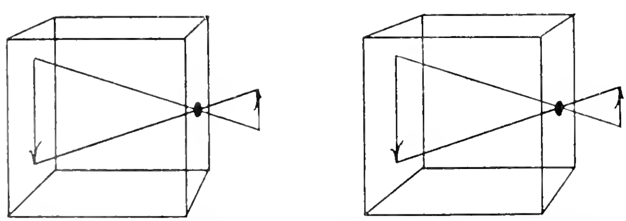
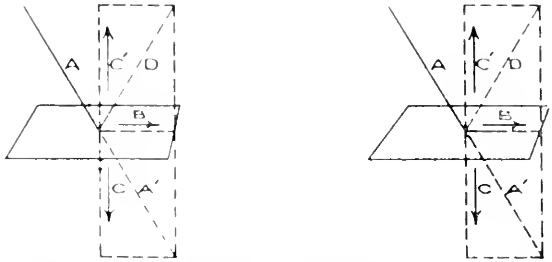
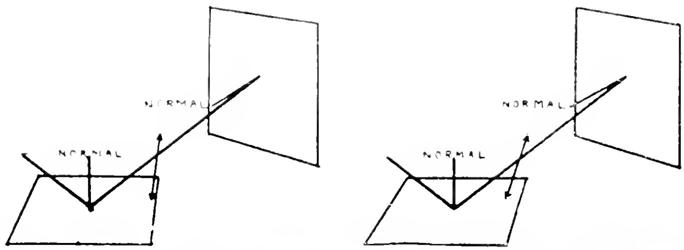


FIGURE 342. The Pinhole Camera, illustrating the formation of the inverted image.



[illegible] Reflexion of [illegible] Ray [illegible] how the principle of the parallelogram of [illegible] reflection.



[illegible] Polarized Ray reflected fr[illegible] [illegible] reflected fr[illegible] pl[illegible] when [illegible]ident upon it at the [illegible] with the [illegible], viz., 54[illegible] de[illegible]

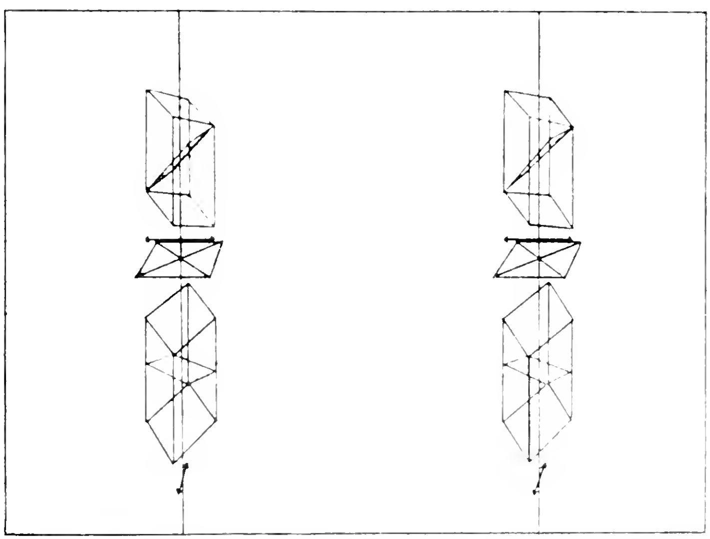


FIGURE 345. Di[illegible] Plane effected [illegible] prism; [illegible] thr[illegible] and, lastly, th[illegible]

FIGURE [illegible].—Crescent-shaped images of the Sun seen under trees during the maximum phase.

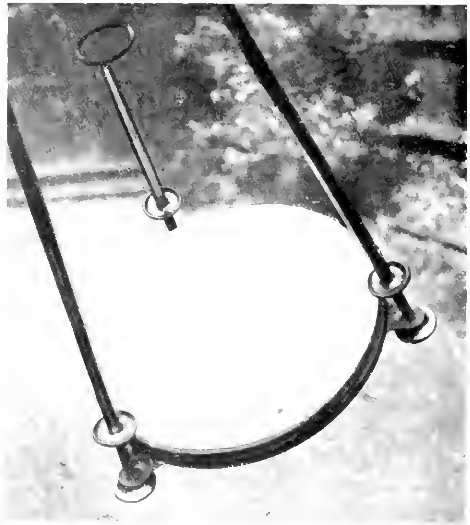


FIGURE [illegible].—Maximum phase in 1914.

[illegible]

FIGURE [illegible].—Maximum phase in 1912.

THE SOLAR ECLIPSE OF AUGUST 21ST, 1914,

VIEWED IN ITS PARTIAL PHASE FROM HAMPSTEAD.

By W. ALFRED PARR, F.R.A.S.

OBSERVERS who had gone abroad to view the recent solar eclipse in its total phase were little to be envied in these turbulent times. Now that Europe has let slip the dogs of war in deadly earnest, the partial phase, as seen at home, acquired an interest and popularity out of all proportion to its intrinsic merits, which were small. In London, at the moment of greatest phase, some sixty-five hundredths only of the Sun's disc were hidden by the Moon, as against about ninety-two hundredths during the eclipse of 1912. Yet the recent eclipse—regarded as a spectacle—had one great advantage over that of two years ago. This advantage lay in the fact that a large spot existed on the Sun's surface, which constituted a point of considerable interest when the Moon's limb crossed it in transit. The spot was plainly visible to the naked eye, and I found it a fairly conspicuous object as the Sun set behind a bank of haze over Hampstead Heath on Wednesday evening, August 19th.

The observations of partial solar eclipses contribute doubtless in but a small degree to the advancement of astronomy in general ; but they are always interesting from a spectacular point of view, and may, in certain circumstances, even yield valuable results to the spectroscopist. This was ably pointed out by Professor Fowler in the *Monthly Notices* of the Royal Astronomical Society * on the occasion of the 1912 eclipse, when, using a six-inch equatorial in conjunction with an Evershed spectroscope, he succeeded for about a quarter of an hour on either side of mid-eclipse in observing hundreds of the Fraunhofer lines brightly reversed. He adds that the appearance of the spectrum strongly recalled that of the flash spectrum photographed during total eclipses, and concludes his paper by expressing the opinion that " partial eclipses, and the partial phases of total and annular eclipses, might be utilised for spectroscopic observations to a much greater extent than has hitherto been the case." It is true that Professor Fowler's highly stimulating results were obtained when the magnitude of the eclipse ranged from 0·8 to 0·9. Under these conditions the extent of the projection of the chromosphere beyond the solar cusps would be considerably greater than its radial depth, which is generally taken to be from five to six thousand miles, this latter, of course, being the maximum amount ordinarily available for spectroscopic examination without an eclipse.

But when, during the partial phase of an eclipse, the advancing dark body of the Moon shuts out the light coming from the solar photosphere, there is a point at the solar cusps where chromospheric light can be studied with an advantage which varies in proportion to the magnitude of the phase. This advantage begins to make itself felt as soon

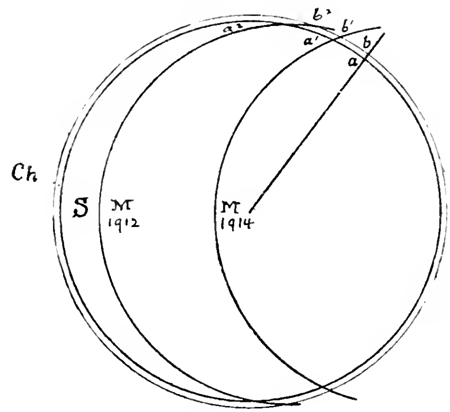


FIGURE 350.

as the angles at the cusps become less than ninety degrees. Thus the conditions in 1912, when the maximum phase amounted to 0·92, were favourable ; but during the recent eclipse the phase never amounted to more than 0·65—as seen from London, at least—and the possibility of obtaining a view of the unobstructed chromospheric spectrum was correspondingly diminished. This will readily be understood on referring to Figure 350, where, for the sake of clearness, the depth of the chromosphere has been exaggerated. If S be allowed to represent the Sun, surrounded by the chromospheric layer Ch, then the short distance $a\,b$ would represent the radial depth of the latter, as seen without the aid of an eclipse. The longer distance $a^1\,b^1$ would show the extent of the chromosphere projecting beyond the solar cusp at the moment when the Moon's limb occupied the position M 1914, as during the maximum phase of the recent eclipse ; while the still greater distance, $a^2\,b^2$, would represent the very favourable conditions obtaining during the

* See *Monthly Notices*, R.A.S., Volume LXXII, No. 7, page 538.

maximum phase of the 1912 eclipse, when, thanks to the magnitude of the phase, a considerable amount of comparatively pure chromospheric light was made available for the spectroscope.

On comparing the photograph of the projected image of the 1914 eclipse (see Figure 348) with that of the 1912 eclipse (see Figure 349) the actual conditions obtaining at both become strikingly apparent. The photographs—unfortunately not on the same scale—were taken at the moment of maximum phase in each case in order to secure a rough record of the two events. Figure 347 shows the means adopted for projecting the image, and a few seconds only were necessary to remove this after the maximum phase had been photographed.

But, in spite of this year's unfavourable conditions and the meagreness of my instrumental equipment, which consisted merely of a three-and-a-half-inch refractor, used in conjunction with a small direct-vision grating spectroscope, I made an attempt to catch a glimpse of the flash spectrum. Fortunately my instrument, though small, was equatorially mounted and clock-driven, so that, by simply rotating the spectroscope, I was able to keep the slit fairly up to the solar cusp. Working in this way, I certainly noticed that many of the bright Fraunhofer lines were easily observable, especially in the neighbourhood of D and E; but, beyond the fact that these lines were more readily reversed bright than is usually the case, I am unable to speak with certainty in the matter, as my small spectroscope offered no handy means of identifying them.

I found some compensation, however, in the beautiful spectrum of the great spot, where the increased absorption over umbra and penumbra was very noticeable in the marked accentuation of the lines.

After obtaining the maximum phase record shown in Figure 348, and searching spectroscopically in the above-described manner for the bright reversal of the Fraunhofer lines, the remaining moments of the eclipse were devoted to direct visual observations, made with the aid of a sun-prism and dark-wedge eyepiece magnifying some eighty diameters. Of these observations the most interesting was the transit by the Moon's limb of the great spot. The transit across the outer margins of the penumbra was accomplished in a little over three minutes, and it was instructive to note the intense blackness of the lunar limb when in close proximity to the umbra of the spot, which appeared dark grey in comparison, while the Moon's limb itself showed marked irregularities, especially towards the south.

Of meteorological changes there is little to record. A self-registering thermometer exposed to the Sun's rays throughout the eclipse showed a fall of temperature amounting to some twelve degrees a little after mid-eclipse. Standing at ninety-four degrees at the commencement, it fell to eighty-two degrees at 12.30 p.m., and rose to ninety-four degrees again by 1.40 p.m., nineteen minutes after the end of the eclipse. But it should be stated that cloud came up for a very short spell about midday. At the moment of greatest phase, however, viz., at 12.11 p.m., the sky was perfectly clear again. At the 1912 eclipse the same thermometer, exposed under identical conditions, recorded a fall of twenty-two degrees, the minimum temperature again occurring about ten minutes after mid-eclipse.

The diminution in sky illumination, so marked at the previous eclipse, was scarcely noticeable this time—a fact which is well brought out on comparing Figures 348 and 349. In Figure 349 the Sun appears as a thin bright crescent, but in Figure 348 it is plain that the general sky light is sufficiently powerful to render the image of the solar crescent, as projected upon the screen, comparatively faint.

Another interesting feature, well shown in Figure 348, is the general darkening of the solar disc towards the limb, caused by the light-absorption of the Sun's smoke-laden atmosphere. This darkening here appears in its usual telescopic aspect, and not with the exaggerated effect seen in direct photographs of the Sun, where the redder, and consequently less actinic, rays transmitted to us by the increased selective absorption going on at the limb produce an undue effect of contrast on the photographic plate.

The crescent-shaped images of the Sun seen under trees during the maximum phase were duly noted (see Figure 346).

GIZA ZOÖLOGICAL GARDENS.

From the fifteenth annual report of the Giza Zoölogical Gardens we learn that in the year 1898 the collection at the date of annual stocktaking consisted of two hundred and seventy specimens of ninety-eight forms, while in 1913, to which the report refers, there were one thousand six hundred and thirty specimens, illustrating three hundred and seventy-eight species. Among the animals born in the gardens were five Hyraces, a Sabre-horned Antelope, a Princess Beatrice Antelope, an Addax Antelope, two Kordofan Kudu Antelopes, and two Kordofan Giraffes. The report concludes with notes on the protection of the Egyptian fauna, from which we gather that, although it was only as recently as May, 1912, that the laws regarding shooting licences and the protection of birds useful to agriculture were made, results are most encouraging. The success in protecting the Cattle Egrets has so far exceeded the most sanguine expectations. Considerably over a thousand birds were hatched and reared during 1913. Reports from various provinces mention that the birds have appeared in the fields of villages where they had not been seen for ten or twelve years. Only one case of Egrets illegally taken has been reported, and that proved to have had the well-meant intention of founding a fresh colony in a province in which these birds have become extinct.

FLORA SELBORNIENSIS.

WITH SOME COINCIDENCES OF THE COMING AND DEPARTURE OF BIRDS OF PASSAGE AND INSECTS, AND THE APPEARING OF REPTILES, FOR THE YEAR 1766.*

UNDER the title of "A Garden Kalendar" Gilbert White for sixteen years kept a diary of the operations and interesting occurrences which took place in his garden. Towards the end of this period, which extended from 1751 to 1767, his scientific interest in wild plants increased; and, having bought a copy of Hudson's "Flora Anglica" in 1765, "The Garden Kalendar," thenceforth spelt with a "C" from August onwards, began to contain entries of a botanical nature. In the following year (1766), instead of being inserted in the "Garden Calendar," the Natural History Notes were separated, and kept in a special diary called the "Flora Selborniensis," with a second title, "The Calendar of Flora." This was the forerunner of "The Naturalist's Journal," begun in 1768, and continued by Gilbert White until his death in 1793.

The first serious attempt of the author of "The Natural History of Selborne" to record his observations in the subject which made him famous, has a very special interest, and it is intended to reproduce facsimiles of the pages of the "Flora Selborniensis," and to publish some notes with regard to the various entries, beginning with the month of October.

OCTOBER, 10TH MONTH.

1. It will be noted that Gilbert White nearly always uses pre-Linnean names—which are practically short descriptions—for his plants, while for birds, binomials are given.

   Here he recognises that *Caucalis arvensis* is very near to *C. anthriscus*, which Bentham and Hooker say is often mistaken for it.

   In "A Naturalist's Calendar," extracted by J. Aikin from Gilbert White's "Naturalist's Journal" for the years 1768–1793, the date of the earliest appearance of the Woodcock (*Scolopax rusticula*) is given as September 29th, and the latest November 11th. As a great many more Woodcocks now nest in the British Isles, it is not so easy to fix the date of the earliest arrival. As a rule, foreign Woodcocks do not come till the middle of October.

5. One day earlier and one month later are the extreme dates given in "A Naturalist's Calendar." Very much later ones have been recorded, namely, the end of November and the beginning of December. For the precise dates see *The Zoologist*, 1881, page 62, and articles on "Swallows in Winter" (*The Field*, January 22nd, 1887) and "Belated Swallows" (*The Field*, January 30th, 1892).

   Gossamer is given as appearing from October 15th to 27th.

10. The Guernsey Lily (*Nerine sarniensis*) belongs to the Amaryllidaceae, and is really an exotic, coming originally from South Africa. Spurrey (*Spergula arvensis*) flowers throughout the summer. Presumably the entry is made as indicating the lateness of the occurrence.

13. This is a late date for the Woodlark (*Lullula arborea*) to be singing. Probably the weather was mild. The Hedge Sparrow (*Accentor modularis*), like the Wren (see below), may often be heard in winter.

14. The Strawberry-tree (*Arbutus Unedo*) is put down in "A Naturalist's Calendar" as flowering on October 1st.

17. Taking Selborne as being two hundred feet above sea level, a barometer reading of 30·0 would correspond to a sea-level pressure of 30·63. Mr. William Marriott has kindly supplied the following records: 31·007 on February 24th, 1808, at Gordon Castle, Banff; 31·108 on January 9th, 1896, at Ochtertyre; 31·110 on January 31st, 1902, at Aberdeen; 31·097 on January 28th, 1905, at Falmouth.

    The Common Snake is now called *Tropidonotus natrix*, and the Blindworm *Anguis fragilis*. The Drone Fly (*Eristalis tenax*) is easily recognised from the entry.

    It is not so easy to identify the second fly from Ray's description, but in Linnaeus's copy of "Historia Insectorum" the name *M. pellucens* is written on the margin. This species, Mr. F. W. Edwards tells me, is now *Volucella pellucens* L. ("Syst. Nat.," Ed. 12, Vol. 1, page 989). As neither Mr. Edwards nor other collectors to whom he has spoken have noticed that the fly smells of musk, while there is no statement in the literature of the subject to this effect, it seems likely that Gilbert White's *Musca moschata* is not *Volucella pellucens*. Moreover, his observation that

* The Plants are according to Mr. Ray's method; the Birds according to Mr. Willughby's ornithology; the Insects according to Ray's "Hist: Insect:" and the Reptiles according to Ray's "Synopsis Animalium Quadrupedum."

Octob^r: 10^th: month. 57.

1. Small corn-parsley, Caucalis segetum
minor, anthrisco hispido similis, blows, & seeds.
4. The first great rain
My late garden-asters, & golden-rods begin to
flower.
1. The wood-cock, scolopax, returns.
5. Swallows, & martins gone.
Rooks steal the wallnuts from y^e trees.
Spiders webs appear.
10. The Guernsey-lilly, Amarillis spathâ multi:
:florâ, corollis æqualibus patentissimis revo:
:lutis, genitalibus longissimis, blows.
Spurrey, spergula, flowers.
12. White frost, & Ice.
13. Apples, & pears are gathering.
Woodlark sings.
Provence, & monthly roses blow.
The hedge-sparrow, curruca, pipes in the morning.
14. Strawberry-tree, Arbutus, blows.
White frost, & Ice.
The buck, dama, grunts, & goes to rut.
17. Barometer is very high at 30 inch: & 4 10^ths

58. Octob.r 17. Black cluster-grapes are delicate.
Common snake, natrix torquata, still appears.
The blind-worm, or slow-worm, Cæcilia, is seen.
Catkins of the alder, alnus, are formed:
The cones are full of seed.
Musca apiformis, tota fusca, caudâ obtusâ, ex
erucâ caudatâ in latrinis degente orta, still is
seen. This fly frequents sinks, & jakes, where it
lays it's eggs. In the autumn it feeds on the flowers
of late annuals, & perennials; & in particular
on the blossoms of Ivy. Ray hist: Insect: 272.
Musca bipennis major, diversicolor, caudâ setis
nigris obsitâ appears, & engenders. This
fly is entirely a garden or field-fly, never entring
into houses: it appears to feed on mellow fruit.
M.r Ray seems not to have been aware that it
smells strongly of musk: it might therefore not
improperly be call'd musca moschata. 271.
This seems to be an autumn fly altogether.
20. Common wild service-tree, or Sorb, Mespi-
lus apii folio sylvestris non spinosa, seu Sorbus
torminalis, in fruit; but it is hard, & austere still.
21. Wheat springs out of the Ground.
22. The fieldfare, turdus pilaris, returns.

59.

Octob.r 22. The glow-worm, cicindela, appears, & shines faintly.
23. Mulberry-tree is naked.
Rooks carry off the acorns from the Oaks.
The Scotch pine casts it's leaves of last Year.
Wallnut-tree is naked.
24. Plants naturally in bloom still:
Laurustine, Ivy, arbutus, great & less throat-wort, round leaved Campanula, burnet saxifrage, Hawkweeds several, round-leaved, & sharp-pointed, fluellin, blue Devil's bit, knapweed, wild thyme, herb Robert, groundsel, hop-trefoil, soap-wort, yarrow, creeping tormentil, dwarf-cistus, chamomile, great basil, mallow, red pimpernel, small stitchwort, viper's bugloss, milkwort, dandelion, wild marjoram, white horehound, creeping mouse-ear, plowman's spikenard, cat mint, many foreign perennial asters, spotted arsmart, ragwort, marsh thistle, shepherd's purse, pansies, sweet-scented reseda

Plants continued in bloom by accidents, such as a shady situation, the bite of Cattle, &c:
Mullein, wild angelica, daucus, spear-leaved thistle, musk D.o sow-thistle, corn-marrigold,

60. spurrey, red & white clover, crow foot sever:
:al sorts, stinking may-weed, hedge-nettle, charlock,
small field-madder, woody nightshade, thorney ap:
:ple, white dead-nettle, balm, corn-poppy, yellow
Ladies-bedstraw, betony, meadow-saxifrage,
violet common, mouse-ear scorpion-grass, water D°.
wild buglofs, borage, white campion, common daisey.

Octob.r 28. The Red wing, swine-pipe, or wind-
-thrush, turdus iliacus, appears.

Novem.r 4. 11th Month.

Most delicate seed-time. Wheat comes up well.
The fruiting-Ananas are ranged in their beds to stand
the winter: fires begin to be lighted in the stoves.
6. The dragon-fly, libella, appears still. Ice.
The musk-fly, & many field-flies bask in the sun on y
trunks of trees. Bee-flies feed on the blossoms of
perennials.
Barometer up at 30 inch: & 4 10ths
7. Snow, & great showers.
10. Lychnidea blows still.
13. The wren, ~~Regulus~~ ~~Motacilla troglodytes~~, whistles.
The Hanger begins to be naked.
Finished dressing the vines.
Heavy showers which make the springs rise.

this is an autumn fly altogether, does not agree with the dates of capture of the specimens in the British Museum, which range from May 21st to September 12th.

20. The Wild Service-tree is now *Pyrus torminalis*. Here Gilbert White uses a Linnean, as well as a pre-Linnean, name.

22. The extreme dates recorded by Gilbert White for the return of the Fieldfare are October 12th and November 23rd. The third week in October is about the usual time for both Fieldfares and Redwings to arrive. If the weather is cold they appear in the second week of that month. The Glow-worm is the beetle, *Lampyris noctiluca*.

24. The Throatworts are *Campanula Trachelium* and *C. glomerata*. Round-leaved Fluellin is a Speedwell (*Veronica officinalis*); Sharp-pointed Fluellin is *Linaria Elatine*; Spotted Arsmart is *Polygonum Persicaria*; Creeping Mouse-ear is a Hawkweed (*Hieracium Pilosella*); Baum is, of course, Balm; Mouse-ear Scorpion-grass is *Myosotis arvensis*; and the water one, the Forget-me-not, *M. palustris*. Mr. F. A. Bellamy, who has for many years made phenological observations, has found the majority of the plants mentioned in flower as late or later than noted by Gilbert White in 1766. With regard to Milkwort, however, he says that he was quite unaware that this plant could be found in flower in October.

28. The Redwing is *Hylocichla iliaca*. October 10th and November 10th are the earliest and latest dates given in "A Naturalist's Calendar." See note under the date October 22nd.

November, 11th Month.

6. See the note with regard to the barometer on October 17th.

10. Lychnidea is the Phlox.

13. The Wren is now called *Anorthura parvula*. See note dated October 15th.

(*To be continued.*)

THE POLE-LATHE.

By WILFRED MARK WEBB, F.L.S.

For some years the present writer has been interested in the rural industries which still survive in a number of our villages. In several instances the very primitive pole-lathe still plays an important part, and wherever it was seen a point was made of securing a photograph.

The first example which came under notice was that belonging to a bowl-turner in Berkshire, which is shown in Figure 353. In this case a strap will be seen, which is fixed to the treadle under the lathe, and passes upwards, taking a turn round the mandrel, or "mamper," on its way to the end of a long, pliable pole above, to which it is attached. When the treadle is pushed down, the mandrel is caused to revolve, and the pole is bent. When the pressure of the foot is released, the pole flies back and causes the mandrel again to revolve, but in the opposite direction. There is not, therefore, a continuous rotary motion in one direction, as in the modern lathe, and this has its advantages, as will be noticed in Figure 351. In this the bowl-turner is seen at work on a wooden bowl with a handle which could not possibly be produced by machinery that is continuously turning the work in the same direction.

The bowl-turner's lathe was fixed in a shed on a common in front of the owner's cottage, but the most simple form of lathe is that which is moved from place to place in the Buckinghamshire woods, and sheltered by a temporary hut, as shown in Figure 352. Here the pole is fastened to a post outside the hut, and carried in through a hole in the screen, over a beam which supports it. These lathes are used for making chair legs, and differ from that used by the bowl-turner in that the cord from pole to treadle passes round the actual piece of work which is being turned. This is well seen in Figure 354, which is taken from a lathe in a chair-making works in an Oxfordshire village, close to the borders of Buckinghamshire. The pole in this case is inside the shed, and passes over a beam, as seen in Figure 355.

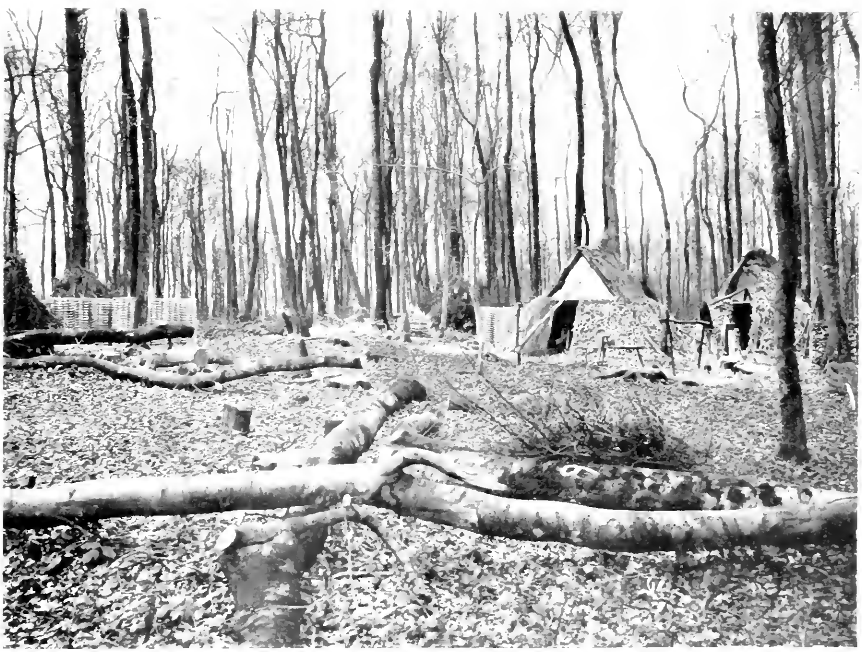
A very similar arrangement was adopted in a Wiltshire village, where there was a chair-making industry, and a photograph of one of the lathes is given in Figure 357.

In a brush-handle factory in Berkshire steam power has been applied to the majority of the lathes, though they are made of wood, and in general construction are little in advance of the pole-lathe. The latter, however, is still retained, as will be seen from Figure 356, for finishing off the mop-handles.

It will be obvious that just as the Archimedean or the bow-drill differs from a centre-bit, or a modern drill, so the pole-lathe differs from the ordinary one; and, as the pole-lathe is apparently older than history, it will be interesting to consider its possible development, and to contrast it with other primitive methods of turning which are still in existence.

(*To be continued.*)

[illegible] Berkshire.

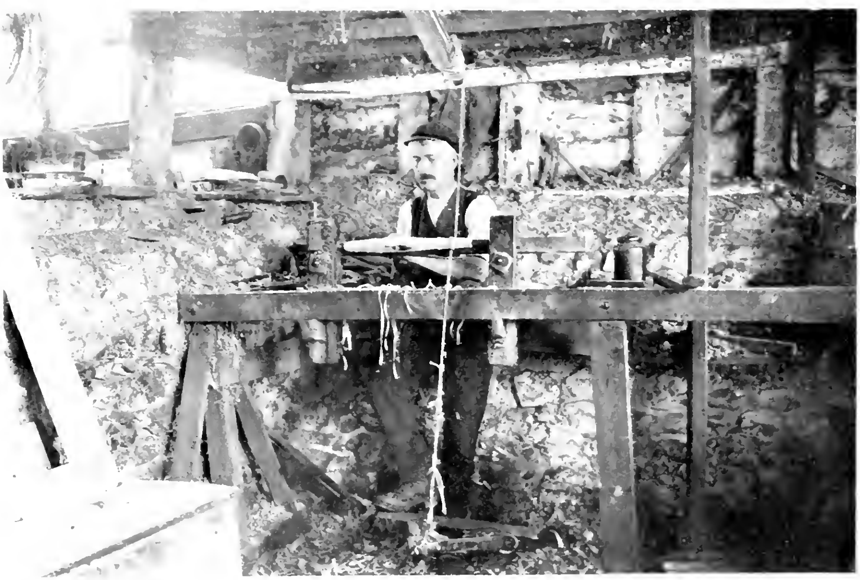


[illegible]

[illegible] General View of the Berkshire Pole Lathe with an ordinary bowl nearly completed.

FIGURE 354. Turning Chair-legs on the Pole Lathe in Oxfordshire.

[illegible] Oxfordshire.



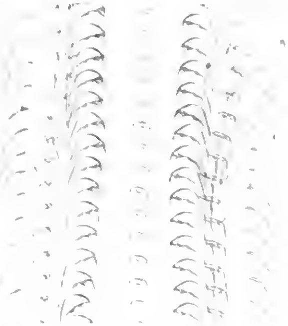


FIGURE 358. The Radula of *Comatias elegans*.
(See page 373.)

The specimen was mounted in euparal.

FIGURE 360. Callipers or Forceps on the terminal segment of the young Earwig (♀). Note the smooth appearance on the curved inner surfaces. × 24.

FIGURE 361. Callipers of Earwig (♀). × 24.

FIGURE [illegible]. Young Earwig (♀) approaching adult stage. The wings are just beginning to appear. × 14.

FIGURE 362. Callipers of Earwig [illegible] × 24.

(See page 373.)

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

THE SOLAR ECLIPSE.—These notes are written before full information has reached me, but it is already obvious that observations have not been entirely frustrated by the war. The Greenwich observers, Messrs. Jones and Davidson, fortunately reached Minsk well before the outbreak of hostilities, and were favoured by fine weather. The Royal Astronomical Society's expedition to Hernosand, Sweden, consisting of Father Cortie, Mr. Atkinson, and others, was also successful: they noted that the coronal type was intermediate between those of minimum and maximum. The coronal spectrum was studied in the longer wave-lengths, while at Minsk the violet end was studied; the two series should therefore supplement each other. Mr. Slater was also in Sweden: his instruments had gone to Riga, but he was unable to follow them. Fortunately he had a four-inch lens with him, and managed to contrive a camera with which some good photographs were taken. This resourcefulness reminds us of Mr. Maskelyne in 1900; his kinematograph failed to turn up at the eclipse, but he improvised another, and obtained successful results. I fear that many observers who sent their instruments to Russia in advance are likely to be deprived of them for a considerable period, but I hope they will eventually be restored. The partial eclipse was well seen in England. The presence of a large sunspot, which was hidden by the Moon, added interest. At Greenwich, for the second time within two and a half years, a meridian observation was obtained of the Moon on the Sun's face. There will not be another meridian eclipse at Greenwich till 1929, but the transit of Mercury on November 7th will take place on the meridian. The next two total solar eclipses are both in accessible regions, viz.: 1916, February, north coast of South America and Guadaloupe; and 1918, June, right across the United States.

PROFESSOR KAPTEYN ON THE DISTANCE OF THE GALACTIC HELIUM STARS.—Professor Kapteyn's papers on the structure of the stellar universe are always worthy of attention, and the one which appears in *The Astrophysical Journal* for July is no exception. It deals with helium stars brighter than the sixth magnitude within 30° of the Galaxy, and between 216° and 360° galactic longitude. Most of the stars in question appear to be moving on almost parallel paths; and, if we assume this as being true of their absolute motion in space, we can deduce the parallax from the observed proper motion and radial motion. Boss's proper motions are used. His General Catalogue contains seven hundred and fifty-two helium stars, of which three hundred and nineteen are discussed in this paper. The stream velocity is determined as 18·3 kilometres per second, and the probable departure of individual stars from the stream velocity is 2·1 kilometres. The observed radial velocities of helium stars are found to require a systematic correction of −4·3 kilometres. The reason is unknown, but the fact has been verified by several people. A map is given of the arrangement in space of the stars considered, projected on the galactic plane. The plotted distances vary from one hundred to one thousand two hundred light-years, there being a decided cluster at a distance of three hundred light-years.

An estimate is given of the distance of the Pleiades, assuming that its motion is parallel to the Galaxy: it comes out one hundred and eighty light-years. Another interesting case discussed is the distance of the Perseus cluster, for which Messrs. Adams and Van Maanen announced last year the high radial velocity of −43 kilometres per second. From four helium stars in the cluster the distance is estimated at four thousand seven hundred light-years, in good accord with Newcomb's estimate of the distance of parts of the Galaxy. Kapteyn thinks it very unlikely that the Perseus cluster is nearer than one thousand five hundred light-years. The Lesser Magellanic Cloud gave the enormous distance of seventy-five thousand light-years. It is noted that Hertzsprung by another method found its distance to be thirty-six thousand light-years. The two estimates are in good agreement, considering the nature of the problem. Both are based on the assumption that there is no absorption of light in space. On the assumption that a star at a distance of thirty-two light-years loses 0·02 magnitude through absorption, then the distance of the Lesser Magellanic Cloud would be eight thousand light-years on Hertzsprung's method.

A further section of Kapteyn's article deals with the relation between distance and colour index. He takes it as established that if two stars have the same apparent magnitude, and the same spectral lines, that further away has the greater colour index. As a first approximation he takes the law

$$\text{Colour index} = g + C \times \text{distance},$$

where g, C are constants, of which g depends on the spectral class, and is already known from the stars near our system. If C can be found, the above equation will give the distance. Professor Kapteyn hopes it may be possible to evaluate it with the aid of a list of parallaxes of distant objects deduced by his own or Hertzsprung's method.

The Observatory for September contains some remarks by Professor H. C. Plummer on Professor Kapteyn's article. He had already published in the *Monthly Notices* hypothetical parallaxes for a number of stars of early type deduced by a method similar to that of Kapteyn, and he compares the results of the two investigations. In the majority of cases the parallaxes are of the same order of magnitude, which increases our confidence in their approximate accuracy. In other words, the method has enabled us to estimate with fair accuracy the distances of stars twenty or thirty times as remote as those for which we can directly measure the parallax. Professor Plummer notes that, though the helium stars are spoken of as forming a "stream," it is quite likely that they are in reality almost at rest with respect to the centre of gravity of the stellar system.

DELAVAN'S COMET.—We may expect this comet to be fairly conspicuous during October. It passes perihelion on the 26th, on which day it is 7° north of Arcturus. The following ephemeris (for 11 p.m.) is by Professor G. van Biesbroeck, of Uccle. The elements on which it is based are very accurate.

	R.A.	N. Dec.		R.A.	N. Dec.
	h m s	° ′		h m s	° ′
Oct. 2	12 7 54	43 54	Oct. 22	13 56 0	29 33
,, 6	12 33 42	41 25	,, 26	14 12 0	26 27
,, 10	12 57 18	38 40	,, 30	14 26 36	23 25
,, 14	13 18 48	35 43	Nov. 3	14 40 0	20 29
,, 18	13 38 18	32 49	,, 7	14 52 24	17 41

On October 10th the comet will be near α Canum Venaticum (Cor Caroli); on November 4th near ξ Boötis. For the greater part of October it will be visible both in the evening and the morning, owing to its being so far north of the Sun.

Professor Barnard writes that on July 28th the comet was easy to the naked eye; in a five-inch telescope a considerable tail was seen, and the nucleus was stellar. A photograph showed a fan-shaped tail 1½° long.

On August 3rd the magnitude was fully 4½. A photograph showed a wide tail with a curious lateral streamer on the north side.

Observers with cameras should secure numerous photographs of the tail during October. The two great sources of cometary information, the Centralstelle telegrams and the *Astronomische Nachrichten*, have been cut off by the war, so we shall be more dependent than usual on home efforts in finding and following comets.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

PLANT INVASION ON HAWAIIAN LAVA FLOWS.—The revegetation of Krakatau, which was deprived of vegetation by a series of volcanic eruptions in 1883, has been followed out by Treub, Ernst, and other observers. A detailed account is given in "The New Flora of the Volcanic Island of Krakatau" (Cambridge University Press, 1908). Successive lava flows from Mauna Loa, in Hawaii, by far the largest volcano in the world, have afforded an opportunity for similar observations there, especially as the age of many of the flows is exactly known. Forbes (*Occ. Papers Mus. Polyn. Ethn. and Nat. Hist.*, Vol. 5) has published a preliminary account of the plant invasion of some of these flows. The lava is of two well-defined kinds, called by the Hawaiians "pahoehoe" and "aa": the former has a smooth, but billowy, or hummocky, surface, and is marked by lines showing that it cooled as it flowed, while the "aa" is lava broken into fragments having sharp and jagged edges, probably owing to subterranean moisture having made it cool from below upward, instead of from above downward, as in the case of the "pahoehoe." On 1859 flow Forbes found no vascular plants on the "aa," though the surface was often white with lichens; while, contrary to what might have been expected, the smooth "pahoehoe" was much more richly covered with vegetation, which, however, occurred only in cracks. On a 1907 flow plants were found just beginning to be established. Evidently on both types of lava the first pioneers are low plants, like algae and lichens; on the "pahoehoe" these are soon succeeded by ferns and seed-plants, but on the "aa" there is a long-enduring lichen stage. Ultimately the natural forest of the region returns, except in places where man's influence causes the successful invasion of a naturalised flora. In this forest a species of *Metrosideros* is the dominant tree at first, while an *Acacia* is the dominating tree of the ultimate or climax forest.

THE GNETALES AND THEIR AFFINITIES.—During recent years a large literature has accumulated around this remarkable group of Gymnosperms. The morphology of the reproductive structures in the three genera—*Gnetum*, *Ephedra*, *Welwitschia*—has now been worked out in considerable detail, but the result has been, on the whole, simply to emphasise their isolated position among Gymnosperms, living and fossil, as well as the sharp differences between the three genera, which should be regarded as constituting three distinct families, if not orders (cohorts). Lignier and Tison have recently published two papers on the group (*Ann. Sci. Nat. Bot.*; *Compt. Rend. Ac. Sci. Paris*). In the first paper they point out that, although the group has no fossil representatives, the recent thorough study of the three genera has provided facts for various generalisations. In *Welwitschia* the male and female cones have an essentially similar organisation; in the middle fertile region each bract bears in its axil a flower comprising five whorls of organs. In the male flower the two lower whorls are reduced to scales, sometimes with reduced vascular bundles; the third whorl bears the pollen-sacs (synangia); the fourth and fifth constitute an abortive four-carpelled ovary, which most botanists have regarded as the integument of the ovule; the latter is, according to Lignier and Tison, reduced to the nucellus. In the female flower the lowest whorl is usually absent, but is sometimes represented by two very small bracts, or by two vascular bundles in the cortex of the cone axis; the second whorl is absent, owing to the compression of the flower between this axis and the bract; the third becomes a winged envelope of the fruit; the fourth and fifth constitute the ovary which, as in the male flower, contains a single ovule reduced to the nucellus, but fertile. According to this ingenious interpretation, which the authors apply also to the flowers of *Gnetum* and *Ephedra*, the structure which has hitherto been regarded as an integument, with a prolonged and more or less trumpet-like opening in some cases, is considered to be an ovary with style and stigma. In their second paper the authors elaborate their views, according to which the Gnetales are primitive Angiosperms, though retaining various characters of Gymnosperms, and showing reduction of the flower such as precludes the idea that they are actually in the direct line of descent of the Angiosperms. They suggest that the Gnetales should be placed beside the catkin-bearing families—the "Amentiferae"—which may be regarded as a branch coming from the base of the Angiosperm trunk, and that perhaps the Amentalian branch has come off from this Gnetalian branch.

CHEMISTRY.

By C. Ainsworth Mitchell, B.A. (Oxon), F.I.C.

CHEMISTRY AND THE WAR.—One of the first effects of the war has been to show us how dependent we have become upon other countries for our supplies of chemical products. Most of our drugs of synthetic origin are derived from German sources, and, as yet, we possess few facilities for supplying the want. Take, for example, the coal-tar product saccharin, which is largely used as a substitute for sugar. The supplies still available in this country are very limited, and will probably be exhausted long before the plant for manufacturing it in England can be erected.

Again, the dyeing industry is already feeling the pinch caused by the stoppage of importations of German dyestuffs, for only a relatively small proportion of aniline dyes is made in this country.

Other directions in which British industries will suffer from this scarcity are to be found in the manufacture of soap, where there will be a lack of potash for soft soaps, and in the photographic industry, which obtains most of its chemicals from abroad.

Several committees have already been formed to consider and advise as to the best means of supplying the chemical wants of various British industries. One of these has been appointed by the Board of Trade, another by the Society of Chemical Industry, and a third by the London Chamber of Commerce, and they include among their members leading chemical manufacturers, experts in the various industries affected, and the principals of technical colleges. Moreover, arrangements are being made to utilise in this country the patent chemical processes of countries with which we are at war.

In the field of pure chemistry, research will suffer considerably through many chemists being called to active service with the armies, and this will apply more especially to France and Germany, where conscription affects all below a certain age. It is doubtful whether many of the chemical journals in those countries will appear regularly, and, in fact, some have already stopped publication.

Apart from the deficient supply of pure chemicals, the work of the research chemist in this country will be handicapped by the want of glass apparatus, flasks, and so on. The best glass for the purpose is that made in Jena, while our supply of cheap flasks is largely derived from Bohemia. It remains to be seen whether the glass manufacturers in this country and America will be in a position to fill the gap.

APOREINE AND ITS SALTS.—An alkaloid with characteristic properties has been isolated by Dr. V. Paveis from the poppy, *Papaver dubium*, and is described in the *Gazzetta Chim. Ital.* (1914, XLIV, 398). This alkaloid, to

which the name of "aporeine" has been given, has a composition agreeing with the formula, $C_{18}H_{16}NO_2$, and forms crystals which melt at 88° to 89° C., yielding a greenish-yellow fluorescent liquid. A distinctive property of the alkaloid is that when dissolved in certain solvents it shows a bluish fluorescence, closely resembling that of quinine salts. It combines with acids to form salts, and yields a sulphate which melts at 70° to 75° C., and when exposed to air and light decomposes, forming a red-brown powder.

DETECTION OF CASTOR SEEDS.—A biological method of detecting the presence of castor seeds in oil-cakes used as feeding stuffs for cattle is described by Messrs. Lander and Geake (*Analyst*, 1914, XXXIX, 292). It is based upon the fact that an extract of the seeds will yield a precipitate with antiricin serum in the presence of ricin, the active constituent of castor seeds. As a confirmatory test, blood-corpuscles are thoroughly washed and suspended in salt solution, and the mixture treated with the extract. Mixtures of linseed, with ten per cent. or more of castor seed, cause rapid agglutination of the blood-corpuscles, but with smaller proportions the reäction is less pronounced. Proof that the agglutination is due to the ricin may be obtained by mixing equal quantities of the extract from the seeds with ordinary serum and with antiricin serum and adding to each the same amount of the blood-corpuscle suspension. If agglutination is checked in the antiricin mixture, the presence of ricin is indicated.

ENGINEERING AND METALLURGICAL.

By T. Stenhouse, B.Sc., A.R.S.M., F.I.C.

CORROSION OF CONDENSER TUBES.—In a previous note the results of an investigation, by Dr. G. D. Bengough and Mr. R. M. Jones, on the causes of corrosion in condenser tubes were described. For the most part the results obtained gave experimental support to the views generally held by engineering chemists, but one conclusion arrived at by the investigators came as a great surprise to all. This was "that even under the most favourable conditions that can be devised to exhibit electro-chemical attack on brass by carbon and copper no such action takes place, and that in consequence the settling of particles on condenser tubes is not *per se* a cause either of dezincification or of any intense local complete corrosion inducing a pit." It may be observed here that in present-day practice a marine condenser almost always consists of a cylindrical casing containing a large number of brass tubes through which seawater is pumped, the steam being condensed on the outer surfaces of the tubes. The point in question has now been further investigated by Mr. Arnold Philip, the Admiralty Chemist, whose results are given in a paper presented to the Institute of Metals. Test pieces of condenser tube were placed in contact with coke in running seawater for sixty days, while other test-pieces, not in contact with coke and supported in different ways, were exposed for comparison in the same seawater for the same period. At the conclusion of the experiment the pieces in contact with coke were all badly corroded, while the others were little affected. Quantitatively the strips out of contact with coke gave a relative mean corrosion velocity varying from 1 to 1·7, according to the freedom with which the seawater was able to circulate around the test-pieces. Those in contact with coke gave a relative corrosion velocity of nearly twenty-five. As the author says, the accelerating effect of coke on corrosion long ago attained the status of an ancient and respected truism, and these results will without doubt cause engineers to return to their old belief on this point.

GEOGRAPHY.

By A. Stevens, M.A., B.Sc.

EXPLORATION.—*The Geographical Journal* for September contains a comprehensive story of the work of the Australasian Antarctic Expedition by Sir Douglas Mawson. The account of the travels of the shore parties, and of the voyages undertaken by the ship "Aurora" is well illustrated by maps and photographs. There is added an outline of the scientific work, from which it is seen that, when the material collected has been completely studied and worked up, the Expedition will have made remarkably valuable contributions to several departments of science.

An expedition, equipped and led by Dr. Bruce, left Tromsö on July 24th, on the sailing ship "Pelikane," for a two months' sojourn in Spitsbergen. The programme includes surveying and hydrographic work, by Dr. Bruce's party in the inlets of the area, and geological work, by a party on the east coast of the mainland. In view of the commercial possibilities of Spitsbergen, the Expedition has a special interest.

THE STRENGTH OF THE EARTH'S CRUST.—Those who are interested in the larger Earth problems may be referred to a series of articles of great interest which are at present appearing in the *Journal of Geology* under the name of Mr. J. Barrell. The current part (Part VA) deals with the questions affecting the problem of Isostasy and Gravity Anomalies.

TYPES OF STREAM VALLEYS.—The same journal contains an analysis of certain types of stream valleys by Mr. J. L. Rich. The types are three, named in the article: (1) The Open Valley; (2) The Intrenched Meander Valley; (3) The Ingrown Valley. Valleys of the first type are approximately straight, or wind about in broad open curves. Their sides are straight, and the stream winds from side to side in large curves, which only in the earliest stages correspond with the curves of the valley. Valleys of the first type run in meanders, due to an earlier cycle of erosion, which have been sunk into the country rock. In the case of the third type the meanders may be inherited; but, as the stream sunk its channel, the meanders grew and expanded. The examples discussed are mainly American, and the three types respectively are exemplified by the Kanawha River, the Kentucky River (type 3 also), and the Elkhorn Creek. The author concludes that the forms of valleys are determined by the ratio of the rate of vertical to lateral cutting and to sweep. Predominant down-cutting gives rise to valleys of types 1 and 2, while predominant sweep gives type 3.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

GENETIC CLASSIFICATION OF ROCKS.—Another method of classifying rocks on a genetic-geological basis is proposed by Mr. T. C. Crook in the current *Mineralogical Magazine*. He lays down two principles which should govern the grouping of rocks: (1) It should be made in accordance with a geological grouping of processes; (2) the grouping must be determined by the nature of the process which has conferred on the rock its type characteristics. A classification of geological processes is therefore a necessary preliminary to rock classification. Mr. Crook makes a twofold main grouping into (1) those processes originating in internal causes, and operating deep-seatedly in the Earth's crust, or from within outwards; and (2) processes of external origin operating superficially or from without inwards. It is not made perfectly clear whether only rock-forming processes are thus to be classified, or all geological processes, some of which do not involve rock formation. Furthermore, this classification, whilst geological in a sense, is not according to the nature of the process, but according to its location in the crust. This results in several anomalies in the detailed classification of rocks, which is as follows:—

I.—Endogenetic Rocks, formed by processes of internal origin, which processes operate deep-seatedly, or from

within outwards. High-temperature effects constitute the prevailing characteristic, and the water taking part as an agent is partly of magmatic origin.

(1) Igneous Rocks.
(2) Igneous Exudation Products:
  (a) Contact impregnations and metasomatised rocks, including pneumatolysised.
  (b) Hydrothermal vein rocks.
  (c) Solfataric deposits.
(3) Thermodynamically Altered Rocks, but unfused and unmodified by exudations.

II.—Exogenetic Rocks, formed by processes of external origin, which processes operate superficially, or from without inwards. These rocks are formed at ordinary or comparatively low temperatures, and the water taking part in their formation is of atmospheric origin.

(1) Weathering residues.
(2) Detrital Rocks, comprising aeolian, alluvial, and marine sediments, loose or cemented.
(3) Solution Deposits, loose or cemented.

  (i) Surface-solution deposits:
    (a) Organic deposits.
    (b) Inorganic deposits.

  (ii) Descending-solution deposits:
    (a) Certain vein deposits.
    (b) Metasomatised rocks.

(4) Subaërial Plant Accumulations and their Products. A few critical remarks may be made on this scheme. It would appear that lavas are exogenetic rocks according to the above definition. For while the actual material is of deep-seated origin, the processes which give lavas their distinctive characters (textures indicative of rapid cooling, flow structures, vesiculation, etc.) operate superficially, and at ordinary or comparatively low temperatures, although the water involved is not usually of atmospheric origin. Then, too, the terms "endogenetic" and "exogenetic" are used with regard to the Earth's crust, and not, as in Grabau's classification, with regard to the nature of the process. This involves the appearance of vein rocks, formed essentially by the same process (crystallisation or precipitation from solution), in both main divisions of the classification, because the process in one case operates deep-seatedly, and in the other more or less superficially. Thus, indeed, comes about the non-appearance of the whole group of solution deposits in the division that contains igneous rocks, although both types are formed by essentially the same process, crystallisation or precipitation from solution. The actual nature of the process would appear to be more important in classification than its location in the crust, or the temperature and pressure at which it is carried on, or the nature of the vehicle or solvent involved. These occasion secondary and subsidiary differences between rocks, which may well give rise to subdivisions in the classification, but not to its main divisions.

THE IMPERIAL TRANS-ANTARCTIC EXPEDITION.—Mr. Alex. Stevens, M.A., B.Sc., the contributor of our Geography Notes, has been appointed geologist and geographer to the Shackleton Trans-Antarctic Expedition, and will shortly proceed to the Weddell Sea. Mr. Stevens, who is a graduate of Glasgow University, is well qualified on both geological and geographical sides. He obtained his B.Sc. in geology with special distinction, and served a year as Demonstrator in the Geological Department, subsequently being appointed Assistant to the Lecturer in Geography at the University of Glasgow.

It is noteworthy that both the geologists appointed to the Shackleton Expedition—Mr. J. Wordie, B.Sc., now Demonstrator in Petrology at the University of Cambridge, and Mr. Stevens—received their geological training in the Geological Department of the University of Glasgow.

METEOROLOGY.

By William Marriott, F.R.Met.Soc.

GULLS KILLED BY HAIL.—In the August number of *British Birds* it is stated that an extraordinary destruction of gulls and other sea birds occurred at Teesmouth on July 2nd, as the result of a thunderstorm, which was accompanied by the fall of hail and lumps of clear ice. The bodies of three hundred gulls were counted within a distance of three-quarters of a mile, exclusive of those by the side of the breakwater.

WIND DIRECTION AND RAINFALL.—Mr. H. J. Bartlett read a paper before the Royal Meteorological Society on "The Relation between Wind Direction and Rainfall." This was a discussion of wind and rain records at the four observatories of the Meteorological Office—viz., Valencia, Aberdeen, Falmouth, and Kew—for the ten-year period 1901–10. He showed that a large proportion of the total rainfall falls with winds in the south-east and south-west quadrants, except in the case of Aberdeen, where the amount in the north-west quadrant is relatively high. The greatest amounts at Kew and Falmouth are with a south-west wind, respectively twenty-two and twenty-eight per cent. At Aberdeen the south-east wind brings the highest amount, twenty per cent.; while Valencia receives thirty per cent. with south, twenty per cent. with south-east, and fifteen per cent. with the south-west wind during the year. At each observatory there are two months during the year when the proportion of rain occurring normally in one or more quadrants diminishes considerably. For Valencia, Falmouth, and Kew this feature is strongly marked in June and September; while for Aberdeen, where it is less obvious, the months are May and November.

LIGHTNING AND TREES.—Very little reliable information is available on the question of the liability of trees to be struck by lightning. Mr. W. R. Fisher, in his book on "Forest Protection," gives some particulars on the subject. He points out that all species of trees are liable to be struck by lightning, but oaks and other species with deep roots appear to be most exposed to this danger, perhaps on account of their roots forming better conductors to the moist subsoil than those of shallow-rooted species. In the *Revue des Eaux et Forêts* the results are given of fifteen years' experience in a forest composed as follows:—

	Oak.	Beech.	Spruce.	Pine.	Others.
Percentage of trees ...	11	70	13	6	...
Trees struck by lightning	159	21	20	59	20
Relative frequency ...	48	1	5	33	...

This agrees with the results obtained by Dr. Hess in the forests of Lippe-Detmold from 1874 to 1890. Local circumstances, such as proximity to lakes, dampness of soil, density of growth, healthy or unhealthy condition of trees, affect the question whether one species will be more liable to attack than another in any particular locality. Starchy trees (oak, poplar, maple, ash, elm) are more in danger from lightning than oily trees (beech, walnut, birch, lime). Damp soils conduct electricity well, but in dry places, when the lightning has reached the ground, it may be spread from root to root of neighbouring trees, and cause them to die in groups.

As all kinds of trees are more or less liable to be struck by lightning, one cannot too strongly urge persons not to seek shelter under a tree during a thunderstorm.

THE METEOROLOGICAL OFFICE.—From the Report of the Meteorological Committee for the year ending March 31st we learn that the Parliamentary Grant has been increased from £17,000 to £20,000, and that this has enabled the Committee to considerably improve the organisation of the Meteorological Office. An addition has been made to the staff by the appointment of several "junior professional assistants." By increasing their annual contribution to the

Scottish Meteorological Society, the Committee have opened a branch "Meteorological Office" at Edinburgh, and also, by taking over from the Royal Cornwall Polytechnic Society the Meteorological Observatory at Falmouth, they have made it a "Weather Station."

The work of the Meteorological Office is carried on under the following divisions: Marine, Forecast and Storm Warning, Climatology and Statistics, Instruments, and Observatories.

Perhaps the work of the Office which interests most people is the issue of the 8.30 p.m. forecasts of the weather that appear in the next morning's newspapers. In checking the forecasts the weather is considered under the aspects: (1) Wind, its direction and force, and the sequence of its changes within the period of the forecast; (2) weather, state of the sky in respect of cloud, together with precipitation in its various forms; (3) temperature of the day and night and its sequence, as represented mainly by the maximum and minimum temperatures, and (4) fog. A forecast is regarded as successful if it has given a fair representation of the actual facts for the majority of the aspects, and unsuccessful if the aspects which were correctly anticipated were less than half. If all aspects of the facts are adequately indicated in the forecast, the mark of complete success is assigned to it. On this understanding the evening forecasts for 1913 gave the following percentage successes:—

	%		%	
January ...	92,	of which	67	were correct in all points.
February ...	91	,,	58	,, ,, ,, ,, ,,
March ...	88	,,	58	,, ,, ,, ,, ,,
April ...	86	,,	52	,, ,, ,, ,, ,,
May ...	94	,,	62	,, ,, ,, ,, ,,
June ...	96	,,	70	,, ,, ,, ,, ,,
July ...	95	,,	75	,, ,, ,, ,, ,,
August ...	91	,,	77	,, ,, ,, ,, ,,
September	86	,,	65	,, ,, ,, ,, ,,
October ...	89	,,	67	,, ,, ,, ,, ,,
November	88	,,	65	,, ,, ,, ,, ,,
December ...	86	,,	57	,, ,, ,, ,, ,,
Year ...	90	,,	64	,, ,, ,, ,, ,,

MICROSCOPY.

By F. R. M. S.

NEW MOUNTING MEDIA.—In the recently issued seventh edition of his "Microtomist's Vade Mecum," p. 247, Bolles Lee draws special attention to some new resinous media devised by Gilson and manufactured by Grübler. The ingredients are sandarac, salol, camphor, eucalyptol, paraldehyde, and propylic alcohol, but detailed formulae are not published. "Camsal" and "euparal" are the names coined to describe the mixtures. Though I hold very strongly that this method of procedure is undesirable, I have experimented with euparal, and find it a very excellent medium. Bolles Lee uses it with stained material, and finds that it gives him further cytological details; and if this is the experience of one who is so great an authority on mitotic figures, and at the same time so thoroughly versed in every known method of staining, it is clear that euparal should be brought to the notice of biologists in general; since mitosis is a phenomenon of primary importance in every branch of the subject. I have been using it lately for mounting radulae of Mollusca, and find it superior in many respects to the glycerin jelly usually employed. I have before commented in this column on the shortcomings of glycerin jelly, and therefore need not repeat the indictment. The best results are obtained when the preparations are well ringed with brown cement and gold size; otherwise many changes are liable to take place. Euparal has a rather higher refractive index, but gives excellent visibility to the radular structures; it is most easily applied; according to Lee it is permanent. The preparations are more favourable to the photomicrographer than those mounted in glycerin jelly, owing to the absence of internal reflections. Personally, I have found it extremely difficult to obtain a passable photograph of a *Pomatia* radula in glycerin jelly on account of the great thickness of some of the parts. Figure 358 (see page 368, *ante*) shows how well they can be seen in euparal. It may be strongly recommended to all microscopists who have to deal with structures having a refractive index very near to that of xylol balsam, until the chemists can provide us with a true synthetic balsam having a lower refractive index.

E. W. BOWELL.

III.—THE COMMON EARWIG (*Forficula auricularia*).—One of the most familiar types of insect life to be found in the garden and field is the well-known Earwig (*Forficula auricularia*), which can be discovered during the day, hidden amongst the buds, and it is interesting to note that a great dislike to this particular insect has existed for centuries. This arises from a belief that the insects creep into the ears of persons, who are in the habit of sleeping in the open air, and cause death. This idea is most absurd, and any entomologist can soon show that insects considerably smaller than any Earwig would have great difficulty in entering the human ear, and in nearly every case fail in its attempts.*

Another unworthy accusation is made by many people that Earwigs exist specially for the purpose of doing damage to our pet plants in gardens, and consequently all the buds and flowers which show ravages made upon them are assigned to these particular forms of insect life.

The question as to whether Earwigs are mainly carnivorous or herbivorous has been a vexed one for a long time, but evidence deduced from research into this problem points to the fact that the insect is a boon, and not a pest, in the garden. The late W. Wesché, in 1900, showed that, in mounting the whole insect for microscopical slides, the stomach was full of aphides and plant-lice in a more or less disintegrated condition, and also that Earwigs preferred dead insects to fruit or vegetables as food.†

The Earwig is placed in the order Orthoptera, of which the well-known Cockroach is also a prominent member. It is interesting to note that Linnaeus in his classification placed the Earwig amongst the Beetles (Coleoptera); and the reason for this was due to their resemblance in general appearance to the brachelytrous beetles.‡

The essential features of Earwigs show that they agree with orthopterous insects, and consequently they are now placed in that order, next to the Cockroaches. The most wonderful and interesting characteristic of Earwigs is shown in the female, and they stand out with Ants, Bees, and Wasps in this respect conspicuously, in the careful attention given to the eggs and young when hatched until the latter are able to look after themselves.*

This maternal instinct is very unusual in insects not included in the Hymenoptera, and was first noticed by De Geer in 1773, and later by de Kerville in 1907.‡

The writer of this article wishes to say that, much to his surprise, he has found very little is known about the Earwig from the microscopical standpoint, and, except for a few notes on the life-history published now and again in the various journals, this particular insect has received scant attention. He hopes by the following notes to promote a new interest, so that other workers will add further information.

As in the case of the Gnat (*Culex pipiens*)§, the life-history

* "Marvels of Insect Life," pages 73–77. † "KNOWLEDGE." Volume XXIII, 1900, page 61.

‡ *Proceedings of the South London Entomological and Natural History Society*, W. J. Lucas, 1912, pages 21–27.

§ "KNOWLEDGE," 1911, pages 309–13.

and habits of the common Earwig (*Forficula auricularia*) are very simple. The eggs are laid in winter or early spring, and in certain cases can be found in autumn, in small pits dug in the soil, about an inch below the surface, or in crevices between flowers, buds, or leaves.*

The Earwig (♀), with her maternal instinct, carefully covers the eggs with her body as a protection; and, if the eggs become scattered, she immediately sets to work gathering them together by means of her jaws.

In early spring the eggs hatch out, and the insect emerges as a fully formed Earwig, minus wings. It is interesting to note that the larval and pupal stages, so familiar in other forms of insect life, are absent in the case of Earwigs, and the young, as they emerge, are exact replicas of their parents (see Figure 359).

The young Earwig at first is almost transparent, but the colour gradations pass from pure white to deep yellow, and, finally, to dark brown, as found in the adult stages.

One authority states that the head is large and the antennae, also the callipers (see Figure 360), are of disproportionate length; but the photo-micrographs under the same magnifications as used for the perfect insect show the callipers are much smaller and weaker than those present in the adult. The young Earwig possesses the long antennae and perfectly formed legs as found in the adult insects; the segments of the abdomen vary according to the sexes, those of the female numbering seven, whilst the male number nine.†

The change in the young Earwig from the wingless to the winged form is produced by a series of moults, or ecdysis stages, numbering four, and it is only in the last moult that the wings appear.

The fully formed insects of both sexes are very similar in appearance, but the male can be easily distinguished from the female by examination of the shape of the ferocious callipers, or cerci, situated at the hinder end of the abdomen. In some species these callipers attain an enormous size, and even in Forficularia one variety possesses forceps, or callipers, twice the size of the common type known as *Forficula auricularia* var. *forcipata*.

The callipers of the ♀ Earwig are nearly straight, and curve symmetrically about the tips. On the inner edges can be seen irregular grooves, which resemble rough teeth: these enable the insect to move the eggs about, and also to unfold or fold the wings (see Figure 361).

The callipers of the ♂ Earwig are considerably larger than those of the ♀, and appear more formidable by reason of their strong curves and projecting portions near the base, which at this point is very wide. The irregularity of their inner surfaces is not as pronounced as in the ♀, but the curves of each portion show a great resemblance to claws (see Figure 362).

As for their use, this is very obscure, and a disturbed Earwig can be seen to bring over the hinder end of the abdomen as if the callipers were present for self-defence.

A pinch by them on the human skin shows that these weapons are quite incapable of producing any harmful effect, and there is no doubt that the main use of the callipers is to assist in wing folding or unfolding. Other species of Earwigs use their forceps as weapons of offence and for catching or holding their prey, seen very often in Shore Earwigs (*Labidura riparia*). Sopp suggests that the callipers are used for piercing plant tissues, to set free the juices, which can then be taken in as food. There is no doubt that the Common Earwig feeds on vegetable matter, but, as pointed out earlier, they find the most natural food in small insects. So to assume from this that the Earwig is a constant foe of the gardener is not only wrong, but without proof, for common evidence proves otherwise.

W. Harold S. Cheavin, F.R.M.S.

(*To be continued.*)

PHOTOGRAPHY.

By Edgar Senior.

METHOD FOR PREPARING PYROGALLOL.—As "pyro," like most of the chemicals which are employed in photography, is chiefly manufactured on the Continent, a difficulty will no doubt be experienced for a time, at least, in obtaining a supply, as, owing to the existing situation, the usual sources will not be available. It may therefore be of interest to show how a solution of "pyro" for use as a developer may be quite easily and cheaply prepared from time to time by the photographer himself. It is now many years ago that Mr. B. J. Edwards advocated the use of glycerine with the pyrogallic developer, and Professor T. E. Thorpe pointed out that if this substance was used as a solvent for gallic acid, and the solution cautiously heated, there would be no difficulty in effecting its conversion into pyrogallol without any of those secondary products being formed which complicate the reäction and increase the expense of preparing the substance in a crystalline form. Further, it was found possible to obtain a theoretical yield, or seventy-five per cent., of the weight of gallic acid employed, as against thirty per cent., at the most by the old method. In the preparation of pyrogallol by this method a wide test-tube is employed, and into this is placed one hundred and fifty grains of dry gallic acid dissolved in one fluid ounce of pure glycerine; the tube is then closed by means of a loosely fitting cork, through which a thermometer passes with its bulb immersed in the liquid. The contents of the tube are then heated over a sand-bath to a temperature of 185° to 200° Centigrade, the latter limit never being exceeded. During the operation bubbles of carbonic-acid gas will be seen to escape from the liquid; it is therefore necessary to provide an outlet for this gas, either by cutting a notch in the cork or making a second perforation. The heat is continued for a period of about half an hour, or until the evolution of the gas ceases, when the operation is finished. The tube is then allowed to cool, after which the contents are poured out into thirty-three ounces of distilled water (or *cold* boiled water); a solution is thus obtained which contains rather more than three grains of pyrogallol in each fluid ounce—a strength which lends itself very conveniently to most formulae in use. It has been found that the images upon plates developed with solutions of pyrogallol prepared in this way were in no way different from those obtained by the use of an aqueous solution of crystallised pyrogallol as generally employed; while half an ounce of the mixture contained sufficient "pyro" to develop a quarter plate. In containing glycerine the developer resembles that recommended by Mr. B. J. Edwards, which at one time found much favour with many photographers. The images that have been developed with solutions of this kind, however, frequently contain a good amount of yellow stain, but this may be entirely removed by treatment after fixing and washing with the following clearing solution :—

Edwards' Clearing Solution.

Alum	1 oz.
Sulphate of Iron	3 ,,
Water	20 ,,
Sulphuric Acid...	¼ ,,

INDICATORS.—Every photographer finds it necessary at times to employ certain tests in order to ascertain whether a solution is acid, alkaline, or neutral, and for this purpose litmus paper is generally made use of; and, although this is very useful in some cases, its value generally has been considerably overrated; because it indicates the point of neutrality in many cases it is assumed to do so in all. The subject of indicators has, however, received a great deal of attention from chemists, with the result that, in addition to the solitary indicator (litmus) of the photographer, they

* "Knowledge," 1911, page 191.

† *Transactions Entomological Society of London*, Volume I.

have now at their command: Phenolpthalein, methyl orange, turmeric, rosolic acid, cochineal, lacmoid, and so on. The qualities that are most generally useful, however, in indicators are found to be present in comparatively greater perfection in phenolpthalein, methyl orange, and litmus than in the others. Such being the case, it may be of interest to point out the characteristics of these three indicators in respect of the chemicals employed by the photographer. With nitric, sulphuric, or hydrochloric acids any one of the three indicators may be employed, except when the base of neutralisation is ammonia, or ammonium salts are present, in which case phenolpthalein is valueless. With organic acids phenolpthalein is the only one of the three indicators which is reliable, except in the presence of ammonia or its salts, when it is useless; with oxalic, tartaric, and, to an extent, with acetic acid, litmus is reliable, so that with these acids it may be employed in place of phenolpthalein when ammonium salts are present. With citric acid, however, the end reäction is always obscure. With carbonic acid methyl orange is the only one of the three indicators to which the acid is neutral in the cold; while it is only in boiling solutions that this acid is neutral to litmus. Hence it is useless to attempt to neutralise an acid solution with an alkaline carbonate using litmus as an indicator. For the formation of the acid carbonates of sodium or potassium in cold dilute solutions, phenolpthalein is a useful indicator. With sulphurous acid, phenolpthalein is to be recommended as an indicator of the formation of the normal sulphite, while, on the other hand, methyl orange should be employed when it is desired to note the point of neutrality in the formation of the acid sulphite. It follows from this that when sulphite of soda in a strictly neutral condition is required for any photographic purpose then phenolpthalein should be employed as an indicator. If, on the other hand, it is the acid sulphite which is desired, then methyl orange must be used as the indicator. Test-papers, which are, as a rule, much more convenient to the photographer than solutions for which they are used as substitutes, cannot, unfortunately, be satisfactorily prepared from either phenolpthalein or methyl orange, but we may employ turmeric paper in most cases where phenolpthalein is used; while lacmoid paper may replace methyl-orange solution in all cases where the latter is employed, being kept immersed in the solution for a minute or two, and such papers, when properly prepared and kept in good condition, will be found invaluable as indicators.

PHYSICS.

By J. H. Vincent, M.A., D.Sc., A.R.C.Sc.

THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION.—The opening address to the Section of Mathematics and Physics was delivered by Professor F. T. Trouton, M.A., Sc.D., F.R.S., President of the Section. After referring sympathetically to the loss which science has suffered by the death of Sir Robert Ball, Professor Poynting, Sir David Gill, and Mr. Sutherland, he congratulated the Universities of Australia and New Zealand on the large number of their past students who have enriched science by research, especially in subjects connected with radio-activity. The work of Rutherford and others had shown that the stores of energy in the atom were unlocked, and it became a question whether the energy involved in our motion through the luminiferous ether could not be tapped, "despite the ingenious theories of relativity which have been put forward to explain matters away." The readiness with which the doctrine of "Relativity" had been accepted was an exaggerated example of the catholicity of present-day science. Professor Trouton then went on with the main portion of his address, which is abstracted in the following paragraphs:—

ABSORPTION AND ADSORPTION.—Absorption is a process taking place throughout a volume, whereas adsorption occurs at a surface. If powdered glass be put into a solution of a salt some of the salt will leave the body of the liquid and adhere to the surface of the glass. This is a case of adsorption. Roughly speaking, the amount adsorbed increases with the strength of solution, and diminishes with rise of temperature; but many exceptions to these simple rules are found. It seems that the surface adsorbs the salt in two ways—by the solution getting stronger in the immediate neighbourhood of the surface and by a deposition of salt on the surface. The layer of extra strength of solution is exceedingly shallow, being only about 10^{-8} centimetres in depth. In certain cases of anomalous adsorption the solvent is adsorbed, and not the solvend, so that the layer of liquid in contact with the surface is weaker than the bulk of the solution. A well-known experiment in adsorption is to pour a solution of permanganate of potash through a filter of precipitated silica, when it will be seen that the first portions of the liquid to escape are almost free from colour. If the experiment be continued the liquid comes through unchanged, as the surface has taken up all the salt it will retain. In the case of anomalous adsorption the first portions coming through the filter are stronger than the original solution. This happens with the alkali chlorides, provided the strength is below a certain critical value dependent on the temperature.

OSMOSIS.—These investigations should throw light on osmosis, since this must occur across a surface covered with an adsorption layer, and the final condition is an equilibrium between the absorption of water by the solution and that by the membrane. A medium which will allow some substances, but not others, to pass through it is called a semi-permeable medium. The transmission of a liquid through a layer of such a medium or a semi-permeable membrane is called *osmosis*. The ideal semi-permeable membrane is one made of a material which will not absorb any salt from the solution, but only water; but such perfection is seldom found. If a semi-permeable medium, such as parchment paper, be immersed in a solution of sugar, it absorbs less water than if it had been placed in water only. Further, the stronger the solution, the less the water it takes up. The semi-permeable medium increases its volume when it takes up water by a greater amount than that of the water absorbed. The quantity of water absorbed increases with the hydrostatic pressure, and it is possible to increase the pressure until the medium takes up as much water from a solution as it would from pure water under atmospheric pressure. Thus a portion of the medium cannot be in equilibrium with water and solution under the same pressure; but if the medium can be arranged in a layer, so as to withstand pressure, the equilibrium may be attained by having the pressures different on the sides in contact with water and solution. The part of the medium in contact with the solution will be at the greater pressure, and the moisture throughout the medium is everywhere the same. The effect of the adsorption layer over the surface of the semi-permeable medium must be taken account of in the theory of osmosis. This may explain certain anomalies met with in the result of experiments on strong solutions. Experiments on absorption from solutions by solids are very difficult to carry out, but are practicable with a liquid medium. Experiments on these lines have been successfully performed, in which ether constitutes the absorbing medium and sugar in water the solution. By pressure ether can be made to take up the same quantity of water from a solution as it takes up from pure water at atmospheric pressure, and the pressure required to bring this about is identical with the experimentally determined osmotic pressure of the solution. The most interesting fact in connection with the subject of osmosis was discovered by van 't Hoff, who showed that the pressure in question is that due to a gas having the same number of molecules as those of the introduced salt. Thus the salt produces the same molecular bombardment as it would were it in the gaseous state. Professor Trouton

concluded his address by a short discussion of the analogous case of the lowering of vapour pressure by the presence of a salt in water.

RADIO-ACTIVITY.

By Alexander Fleck, B.Sc.

ATOMIC WEIGHT OF LEAD.—During recent months there has been published a number of interesting papers dealing with the atomic weight of lead found in uranium and thorium minerals. The idea that this lead was the product of atomic disintegration was put forward a number of years ago by Professor Boltwood, of Yale University. The probability of the truth of this suggestion was much increased by the discovery of the law governing the passage of radio-active elements through the Periodic Table, enunciated independently in its present form by Fajans and Soddy. This law showed that the final products of the uranium-radium, thorium, and actinium disintegration series should be elements chemically indistinguishable from ordinary lead. The accepted value of the atomic weight of ordinary lead is 207·1, while the law referred to above leads us to believe that lead derived from uranium should be 206, while that from thorium should be 208. The atomic weight of actinium is not known accurately, so it is impossible to predict that of the resulting lead. The results of the experimental determinations are as follows:—

Soddy and Hyman, experimenting on lead derived from thorite—a relatively simple mineral, chiefly composed of thorium silicate and almost free from uranium—found the value to be 208·4. T. W. Richards and M. E. Lembert, O. Honigschmidt and Mlle. St. Horovitz, and Maurice Curie all found that the lead from uranium minerals was lower than ordinary lead (206·4 to 206·6). All these results agree with the theoretical predictions mentioned above.

THE BRANCHING OF THE DISINTEGRATION SERIES.—The fact that the atom of an element can undergo an internal change, referred to as disintegration, as the result of which the atom assumes entirely new properties, produced a complete revolution in scientific thought. Yet that direct change is comparatively simple when compared with the branching of the disintegration series, shown by radium-C, thorium-C, and uranium. Thorium-C was the example first discovered. So far as we know at present, the process is that each atom of a homogeneous collection of thorium-C atoms has the choice of emitting either an α particle or a β ray. What action pulls the trigger to let off one or the other we do not know. Whatever the mechanism, it always happens that thirty-five per cent. of the atoms give off α rays, and that the remaining sixty-five per cent. give off β rays. In the case of radium-C it happens that only 0·03 per cent. give α rays, while 99·97 per cent. give β rays. Evidence has also been obtained by Marsden and Wilson that actinium-C likewise undergoes a dual disintegration. The case of uranium is unique. In all the above examples the atom has the choice of two different kinds of rays, but in this case the choice is between two β rays of different ranges, that is, that the quantity of energy liberated in the different modes is dissimilar. The chemical properties of the resulting products are in this case identical, but their stability is very different, and, as a consequence, these latter elements break up at very different rates.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A., LL.D.

ANCESTRY OF DOMESTIC FOWLS.—As some doubt has been cast on the validity of Darwin's conclusion that the ancestry of domestic fowls is to be found in the Indian jungle fowl, it is satisfactory to note Mr. C. W. Beebe's statement: "After studying all four species of feral *Gallus* in their native haunts, as well as many examples of natural and artificial hybridising, and reviewing the evidence from all points of view, I can find no reason to attribute the ancestry of all varieties of our domestic fowls to other than the red jungle fowl of India, *Gallus gallus* (Linnaeus)."

FLYING CRUSTACEAN.—Dean C. Worcester reports the occurrence of "A Flying Crustacean" from the Philippines, but he has not caught it yet. It was translucent, rose from the sea somewhat sharply, and "flew" not more than two or three rods before dropping into the water again. It was about fifteen to twenty centimetres in length and somewhat shrimp-like. It was seen four times. The specimens invariably rose against the wind.

PRODUCTIVITY OF ORGANISMS.—Many estimates have been made of what would happen if organisms multiplied without let or hindrance. We came across a new one in Professor J. F. Abbott's excellent "General Biology" (Macmillans, 1914). "An ordinary mosquito hatching from the egg reaches maturity and lays her own eggs ten days afterward. A single female lays about four hundred eggs, half of which become females. If a single female should hatch on April 1st, and lay her quota of eggs ten days later, on July 1st, ninety days later, if all lived, the progeny would number 102,914,592,864,480,008,004,001 mosquitoes." We have not verified this.

SOCIAL EVOLUTION AMONG PENGUINS.—Dr. Levick has made a fine study of the Adélie Penguins (*Pygoscelis adeliae*), and gives one much food for reflection. Two facts stand out among many. The first is the custom of forming "crèches" for the chicks when these reach a certain age, in this way. When the chicks are young they are easily fed by one parent at a time. The hen sits and the cock goes down to the sea to fill his crop with Euphausid Crustaceans. He returns, and the chicks are fed. After some fussing, the hen surrenders the task of incubation to her mate, and goes down to the sea; and so it goes on, in regular alternation. But as the chicks grow bigger they require more food, and the turnabout method of collecting this is inadequate. So the parents "pool" their chicks, and form "crèches" which are under the charge of a few old birds inclined to paedagogics. The young are educated a bit, and protected from the intrusive Skuas and the "hooligan" males, who are even worse. The other exhibition of sociality that gives one pause is a kind of "drilling," which was seen only once. The Penguins assembled in bands, thousands strong, and exhibited remarkable orderly movements, just like soldiers at drill. Dr. Levick suggests that this may correspond to the "massing" of birds like Starlings before the autumnal migration.

GALL-FORMING CRAB.—Mr. F. A. Potts has made some very interesting observations on *Hapalocarcinus*, a genus of small crabs, the females of which pass the greater part of their lives confined in small cavities in coral colonies. The young female probably commences her sedentary life by settling down in a notch at the apex of a recently divided branchlet. She is at this period a small flat creature, little more than a millimetre in carapace length. The initial modification of the growth of the coral is probably due to the mere mechanical effect of the continued presence of the crab. The branches, instead of remaining cylindrical, broaden out. They then approximate above and at the sides, thus partially enclosing a chamber. Eventually, a larger second chamber is formed on the top of the first, and the crab passes into this just before fertilisation, when the ovary begins to grow rapidly. Water enters and leaves the gall by numerous small apertures formed by the incomplete closure of what was at first a wide slit. The crab lives on the "dwarf-plankton," which is drawn in with the respiratory current. Mr. Potts discovered the minute free-living male, which seems to visit the females while the gall is still open. Soon after a stock of sperm has been secured, the gall closes up—so far that the visits of other males are prevented. The female lays brood after brood of eggs, which develop to the zoaea stage, and then leave the gall by the small openings.

THE FACE OF THE SKY FOR NOVEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 46.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Nov. 4	14 37·2	S.15·[illegible]	3 36·[illegible]	N.[illegible]1·5	15 1·0	S.18·3	16 39·4	S.27·7	21 5·3	S.17·7	6 [illegible]	N.2[illegible]	20 41·[illegible]	S.19·[illegible]	8 1·[illegible]	N.19·7
„ 9	14 55·1	17·[illegible]	[illegible]	N.2[illegible]·2	14 37·5	14·9	16 39·7	27·3	21 7·1	17·5	6 7·0	[illegible]	20 41·[illegible]	19·[illegible]	8 1·[illegible]	19·7
„ 14	15 15·4	18·1	12 10·0	S. [illegible]·2	14 22·5	12·2	16 35·7	26·[illegible]	21 9·2	17·4	6 6·5	[illegible]	20 41·4	19·[illegible]	8 1·2	19·7
„ 19	15 36·0	19·[illegible]	17 24·7	S.27·9	14 24·0	11·8	16 27·3	25·5	21 11·5	17·[illegible]	6 5·4		20 42·[illegible]	19·[illegible]	8 1·[illegible]	19·7
„ 24	15 57·0	20·4	22 10·7	S.11·3	14 39·9	13·1	16 17·0	24·[illegible]	21 14·2	17·0	6 4·0	22·[illegible]	20 43·3	19·5	8 0·[illegible]	19·7
„ 29	16 15·3	S.21·4	1 45·4	N.15·8	15 2·9	S.15·2	16 5·1	S.22·[illegible]	21 17·[illegible]	S.16·8	6 2·3	N.22·[illegible]	20 44·1	S.19·[illegible]	8 0·[illegible]	N.19·7

TABLE 47.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
Nov. 4	+24·1	+4·0	135·4	−13·4	−13·7	+0·1	74·2	124·[illegible]	0 25 *m*	[illegible]
„ 9	23·1	3·1	69·5	−10·7	13·8	0·1	1[illegible]·8	134·7	0 14 *e*	[illegible] 41 *e*
„ 14	21·9	2·9	3·5	+22·1	13·[illegible]	0·1	201·4	125·1	0 30 *e*	[illegible]
„ 19	20·4	2·3	297·0	+ 4·0	13·2	0·2	269·9	215·[illegible]	2 29 *e*	1 [illegible] *e*
„ 24	18·5	1·7	231·7	−19·2	13·4	0·2	338·4	245·8	0 36 *e*	[illegible] 1 *e*
„ 29	+17·0	+1·0	105·8	−20·1	−13·0	+0·2	40·8	270·1	0 3[illegible] *m*	[illegible] 4 *m*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}8$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving southward but with slackening speed. Its semi-diameter increases from 16′ 8″ to 16′ 15″. Sunrise changes from $6^h\ 55^m$ to $7^h\ 44^m$; sunset from $4^h\ 32^m$ to $3^h\ 53^m$.

MERCURY is an evening star till 7th, when it transits the Sun (transit visible in England) and becomes a morning star. Semi-diameter 5″ at transit, diminishing to 3″ at end of month; at elongation, 20° west of Sun, on 24th.

THE TRANSIT OF MERCURY.—The first contact takes place at $9^h\ 57^m\ 15^s$ *m* on November 7th, 156° from N. Pt. of Sun towards East. $2^m\ 14^s$ later the whole planet will be on the Sun. It will be at its least distance from the Sun's centre (10′ 31″ south) at $0^h\ 3^m\ 22^s$ *e*. It will begin to pass off the Sun at $2^h\ 7^m\ 16^s$ *e*, 255° from N. Pt. towards E, and will be entirely off $2^m\ 14^s$ later. The times given are for the Earth's centre: they will be slightly affected by parallax. The planet will not be visible on the Sun without telescopic aid, and for the benefit of those unaccustomed to view the Sun it is as well to point out the necessity of a proper dark glass, or else the use of the projection method, an enlarged image of the Sun being thrown through the telescope on to a white screen placed behind it. This method enables several observers to work simultaneously. The screen should be shielded from direct sunshine by a large piece of cardboard, in which a round hole is made, to fit on the telescope tube.

The transit is visible in Europe, Africa, South America, and parts of Asia and North America.

The last transit occurred in November 1907, the conditions of visibility in England being almost the same as in the present one. The next will be in May, 1924, followed by one in November, 1927.

The observations of chief importance during the transit are to accurately time the external and internal contacts, and to make micrometric measures of the size of the planet's disc. This last requires a fairly large instrument, equatorially mounted.

Some observers have noted during transit a bright spot on the black disc, and an aureole surrounding it. These were probably optical illusions; but there is no harm in being on the alert for any abnormal appearances.

VENUS is an evening star till 27th, when it passes Inferior Conjunction and becomes a morning star. Illumination diminishes from one-sixth of disc to zero. Semi-diameter increases from 24″ to 32″. The fact of its declination being south of the Sun impairs the conditions of observation for northern observers. The inferior conjunction is 4 of the 8-year periods after the 1882 transit, and is therefore a fairly close one, 1° 37′ south of the Sun's south limb.

THE MOON.—Full $2^d\ 11^h\ 49^m$ *e*. Last quarter $10^d\ 11^h\ 37^m$ *e*. New $17^d\ 4^h\ 2^m$ *e*. First quarter $24^d\ 1^h\ 39^m$ *e*. Apogee $2^d\ 8^h$ *e*. Perigee $17^d\ 4^h$ *m*. Apogee $29^d\ 11^h$ *e*. semi-diameter 14′ 43″, 16′ 45″, 14′ 44″ respectively. Maximum librations 4^d 7° S., 11^d 7° E., 18^d 7° N., 22^d 8° W.

The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 48). Attention is called to the unusually large libration on 22nd, of which advantage should be taken to observe the West limb.

MARS is practically invisible.

JUPITER is an evening star, in Capricornus, 28′ North of ι Capricorni on 30th. Polar semi-diameter, 18″. In quadrature with Sun on 7th; 1° N. of Moon on 23rd.

Configuration of satellites at 6^{h} 30^{m} *e* for an inverting telescope.

JUPITER'S SATELLITES.

Day	West.		East.		Day.	West.		East.	
Nov. 1	3	○	124		Nov. 16	1	○	24	3●
,, 2	1	⊙			,, 17	2	○	134	
,, 3	42	○	13		,, 18	12	○	43	
,, 4	41	○	3	2●	,, 19	4	○	132	
,, 5	4	○	132		,, 20	431	⊙		
,, 6	432	○		1●	,, 21	432	○	1	
,, 7	4321	○			,, 22	43	○	2	1●
,, 8	43	○	12		,, 23	413	○	2	
,, 9	41	○	2	3●	,, 24	42	○	13	
,, 10	24	○	13		,, 25	412	○	3	
,, 11	12	○	43		,, 26	4	○	132	
,, 12		○	1324		,, 27	314	○	2	
,, 13	321	○	4		,, 28	32	○	14	
,, 14	32	⊙	4		,, 29	3	○	4	2● 1●
,, 15	3	○	124		,, 30	31	○	24	

The following satellite phenomena are visible at Greenwich, all in the evening:—2^{d} 5^{h} 7^{m} 26^{s} III. Ec. R., 9^{h} 12^{m} 13^{s} IV. Tr. E., 9^{h} 54^{m} 17^{s} II. Tr. I.; 4^{d} 9^{h} 45^{m} 3^{s} II. Ec. R.; 5^{d} 8^{h} 12^{m} 9^{s} I. Tr. I., 9^{h} 31^{m} 38^{s} I. Sh. I., 9^{h} 57^{m} 9^{s} III. Tr. I., 10^{h} 29^{m} 26^{s} I. Tr. E.; 6^{d} 4^{h} 39^{m} 37^{s} II. Sh. E.; 5^{h} 31^{m} 13^{s} I. Oc. D.; 9^{h} 8^{m} 23^{s} I. Ec. R.; 7^{d} 4^{h} 58^{m} 25^{s} I. Tr. E.; 6^{h} 17^{m} 54^{s}, I. Sh. E.; 9^{d} 5^{h} 31^{m} 5^{s}.III. Ec. D.; 9^{h} 8^{m} 49^{s}, III. Ec. R.; 11^{d} 6^{h} 3^{m} 53^{s} IV. Ec. R., 6^{h} 44^{m} 26^{s} II. Oc. D.; 12^{d} 10^{h} 8^{m} 20^{s} I. Tr. I.; 13^{d} 4^{h} 26^{m} 30^{s} II. Sh. I., 4^{h} 39^{m} 10^{s} II. Tr. E., 7^{h} 15^{m} 31^{s} II. Sh. E., 7^{h} 27^{m} 12^{s} I. Oc. D.; 14^{d} 4^{h} 37^{m} 33^{s} I. Tr. I., 5^{h} 56^{m} 25^{s} I. Sh. I., 6^{h} 54^{m} 58^{s} I. Tr. E., 8^{h} 13^{m} 47^{s} I. Sh. E.; 15^{d} 5^{h} 32^{m} 27^{s} I. Ec. R.; 16^{d} 4^{h} 12^{m} 5^{s} III. Oc. D., 7^{h} 50^{m} 59^{s} III. Oc. R.; 16^{d} 9^{h} 32^{m} 41^{s} III. Ec. D.; 18^{d} 9^{h} 25^{m} 12^{s} II. Oc. D.; 20^{d} 4^{h} 28^{m} 50^{s} II. Tr. I., 7^{h} 2^{m} 32^{s} II. Sh. I., 7^{h} 18^{m} 19^{s} II. Tr. E., 9^{h} 24^{m} 7^{s} I. Oc. D.; 21^{d} 6^{h} 34^{m} 58^{s} I. Tr. I., 7^{h} 52^{m} 16^{s} I. Sh. I., 8^{h} 52^{m} 30^{s} I. Tr. E; 22^{d} 4^{h} 21^{m} 52^{s} II. Ec. R., 7^{h} 27^{m} 44^{s} I. Ec. R; 23^{d} 4^{h} 38^{m} 42^{s} I. Sh. E., 8^{h} 22^{m} 3^{s} III. Oc. D.; 27^{d} 7^{h} 3^{m} 56^{s} III. Sh. E., 7^{h} 9^{m} 38^{s} II. Tr. I., 7^{h} 40^{m} 2^{s} IV. Oc. D.; 28^{d} 8^{h} 33^{m} 12^{s} I. Tr. I.; 29^{d} 5^{h} 51^{m} 25^{s} I. Oc. D., 7^{h} 0^{m} 31^{s} II. Ec. R.; 30^{d} 4^{h} 17^{m} 5^{s} I. Sh. I., 5^{h} 20^{m} 39^{s} I. Tr. E., 6^{h} 34^{m} 41^{s} I. Sh. E.

Eclipses will take place to the right of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN is a morning star, in Gemini. Stationary on October 15th. Polar semi-diameter 9½″. Major axis of ring 46¼″, minor 20½″. Angle P − 6°·2.

Eastern elongations of Tethys (every 4th given) 8^{d} 5^{h}·0 *m*, 15^{d} 6^{h}·2 *e*, 23^{d} 7^{h}·4 *m*. 30^{d} 8^{h}·5 *e*; of Dione (every 3rd given) 8^{d} 0^{h}·9 *m*, 16^{d} 5^{h}·8 *m*, 24^{d} 10^{h}·8 *m*; of Rhea (every 2nd given) 1^{d} 1^{h}·0 *m*, 10^{d} 1^{h}·8 *m*, 19^{d} 2^{h}·5 *m*, 28^{d} 3^{h}·1 *m*.

For Titan and Japetus E., W. stand for East and West elongations, I for Inferior (North) conjunction, S. for Superior (South) conjunction. Titan 5^{d} 2^{h}·2 *m* I. 8^{d} 10^{h}·9 *e* W., 12^{d} 10^{h}·9 *e* S., 17^{d} 1^{h}·3 *m* E., 21^{d} 0^{h}·1 *m* I., 24^{d} 8^{h}·8 *e* W., 28^{d} 8^{h}·8 *e* S; Japetus 3^{d} 3^{h}·6 *e* E., 23^{d} 11^{h}·8 *e* I.

URANUS is an evening star in Capricornus, 1½° North of Moon on 22nd.

NEPTUNE is a morning star, coming into a better position for observation. Stationary on 3rd.

COMETS.—See "Notes on Astronomy" in this number. Delavan's Comet promises to be an easy object to the naked eye.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.		Radiant. Dec.	Remarks.
	°		°	
Nov. 1 ...	43	+	22	Slow, bright.
,, 2	58	+	9	Slow, bright.
,, 10-12	133	+	31	Very swift, streaks.
,, 14-16	150	+	22	Leonids, swift, streaks.
,, 16-28 ..	154	+	41	Swift, streaks.
,, 20-23	63	+	23	Slow, bright.
,, 17-23	25	+	43	Andromedids, very slow, trains.
,, 25-Dec 12	189	+	73	Rather swift.
,, 30 ..	190	+	58	Swift, streaks.

In the cases where the radiant is stated to be active for several months, there is a difference of opinion as to whether it can be regarded as a single shower or a combination of several.

TABLE 48. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reappearance. Time.	Reappearance. Angle from N. to E.
1914.			h. m.	°	h. m.	°
Nov. 6	BD + 27° 880	7·0	—	—	8 59 *e*	301
,, 6	136 Tauri ..	4·6	9 49 *e*	54	10 48 *e*	291
,, 7	BAC 1918	6·1	1 53 *m*	98	3 16 *m*	267
,, 8 ...	39 Geminorum ...	6·2	3 46 *m*	156	4 36 *m*	231
,, 8	BAC 2506	6·3	—	—	8 51 *e*	298
,, 8	BAC 2514 ..	6·0	8 23 *e*	100	9 17 *e*	272
,, 8	BD + 24° 1755	6·8	—	—	11 18 *e*	308
,, 9	BD + 24° 1806	7·0	—	—	6 0 *m*	345
,, 9	η Cancri	5·5	—	—	9 25 *e*	211
,, 13	79 Leonis	5·5	7 24 *m*	145	8 31 *m*	290
,, 14	Wash. 785	7·6	—	—	4 8 *m*	261
,, 29	BD + 16° 247	6·4	7 29 *e*	62	8 47 *e*	234
,, 30	Wash. 176 ..	6·7	8 48 *e*	50	—	—
,, 30	ε Arietis (double)	4·6	9 0 *e*	125	9 40 *e*	183

From New to Full disappearances take place at the Dark Limb, from Full to New reäppearances.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable (see Table 49).

TABLE 49. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
R Arietis ...	2 11	24·7	7·3 to 13·2	186·66	Sept. 22
o Ceti (Mira) ...	2 15	3·3	2·0 to 9·6	331	Oct. 7 (Min^m.
R Ceti	2 22	0·6	7·5 to 12·8	166·88	Sept. 21.
R Trianguli	2 32	33·9	5·3 to 12·0	265·4	Sept. 20.
R Persei	3 25	35·4	7·9 to 13·8	210·3	Sept. 22.

Minima of Algol $4^d\ 5^h{\cdot}7\ m$, $7^d\ 2^h{\cdot}5\ m$. $9^d\ 11^h{\cdot}4\ c$, $12^d\ 8^h{\cdot}2\ c$, $15^d\ 5^h{\cdot}0\ c$. $24^d\ 7^h{\cdot}4\ m$. $27^d\ 4^h{\cdot}3\ m$. $30^d\ 1^h{\cdot}1\ m$. Period $2^d\ 20^h\ 48^m{\cdot}9$.

Principal Minima of β Lyrae November $5^d\ 0^h\ c$. $18^d\ 10^h\ m$. Period $12^d\ 21^h\ 47^m{\cdot}5$.

SOLAR DISTURBANCES DURING AUGUST, 1914.

By FRANK C. DENNETT.

Observations were made on the Sun every day during August, with the exception of the 8th. On four (5th, 9th, 28th, and 31st) the disc appeared free from disturbance, and on twelve (1st to 4th, 6th, 7th, 10th to 12th, 27th, 29th, and 30th) only faculae were seen. The longitude of the central meridian at noon on August 1st was 309° 37′.

No. 24.—A fine spot, first seen on the 13th, within the north-eastern limb, followed by a faculic area. From the 16th until the 22nd some small pores clustered round its eastern half; none, however, were very persistent. There were also some penumbral extensions, which, on the 21st, reached a maximum diameter of thirty-six thousand miles, but the usual diameter of the spot was twenty-six thousand miles, and the length of the group forty-five thousand miles. On the 18th the umbra was almost broken into three by very pale bridges. A bright tongue projected into it from the east, 19th till 21st. The northern part of the umbra was quite cut off on the 23rd until the 25th. The spot was last seen on the 26th.

No. 25.—A group of pores of varying configuration seen from the 16th until the 18th in a faculic area. The greatest length attained was sixty thousand miles. The rear component was much the largest on the 17th.

No. 26th.—A pair of tiny pores visible from the 15th until the 19th.

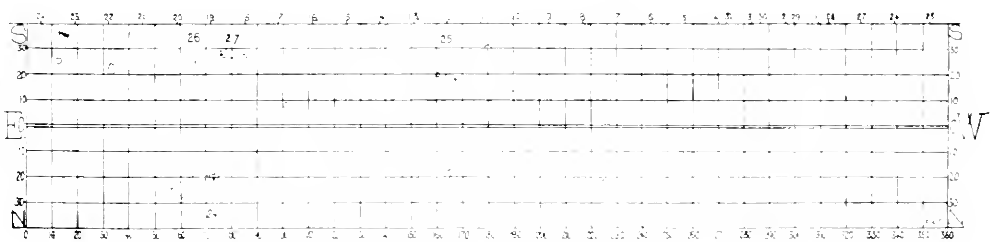
No. 27th.—A small spot and group of pores, some sixty-six thousand miles in length, a little south-west of the last, seen on the 23rd and 24th.

Faculae were observed near the north-western limb on August 18th (164°, 19° N.) and 27th; north-eastern on 7th, 10th, 26th, and 29th (224°, 20° N.); eastern on 11th till 13th (101°, 9° S.); south-western on 1st (32°, 22° S., and 13°, 26° S.), 10th, 11th (219°, 40° S.), 12th till 16th (190°, 14° S., and 180°, 30° S.), 23rd and 25th; south-eastern on 2nd till 4th, 6th, 10th, 11th (104°, 28° S.), 14th, 16th, and 30th; and in the south polar area on the 21st.

During the eclipse on August 21st No. 24 was a beautiful object. Its dark umbra was, however, markedly less dark than the advancing rugged limb of the Moon, which presently covered it. It was of large size, but the spectroscope showed comparatively little disturbance.

Our chart is constructed from the combined observations of Messrs. John McHarg, J. C. Simpson, E. E. Peacock, and F. C. Dennett.

DAY OF AUGUST, 1914.



REVIEWS.

ASTRONOMY.

The Observer's Handbook for 1914.—Edited by C. A. CHANT. 72 pages. 1 map. 6-in. × $4\frac{1}{4}$-in.

(Toronto: The Royal Astronomical Society of Canada. Price 25 cents.)

This useful handbook, the sixth of the series, contains much that is required by the practical astronomer, especially the large body of amateurs. The positions of the planets, Sun, and Moon day by day or during the month are given for 1914, also Jupiter's satellites, together with notes on the various objects in the constellations. There is not much about the variable stars.

F.

Annuaire de L'Observatoire Royal de Belgique, 1914.—By G. LECOINTE.

Les Progrès récents de l'Astronomie (V, *Année* 1911).—By PAUL STROOBANT. 506 pages. 5 plates. 7-in. × $4\frac{1}{2}$-in.

(Bruxelles: Hayez.)

This series has now been continued for a number of years, and the contents include something of the nature of a very condensed English, French, or German nautical almanac, and is intended for use in Belgium. After the usual daily information for the Sun, Moon, planets, and stars in 1914—which occupy one hundred and thirty-four pages—there are chapters on "Le Globe Terrestre," "Les Marées," "Le Magnétisme Terrestre," "L'Électricité Atmosphérique," Tables of Refraction, Rising of the Sun, and so on; Conversion of Mean and Sidereal Time, and Time to Arc, Elementary Ideas on the Measure of Time, Explanation of the Ephemerides and Tables, the Legal Time in different countries, and the Distribution of Time by Wireless Telegraphy: these include one hundred and seventy-one pages. The rest of the *Annuaire* (two hundred and one pages) consists of a necessarily brief review of "Les Progrès récents de l'Astronomie, V, année 1911," by P. Stroobant. Arranged under various subjects, such as the Sun, Planets, and Comets (pages 53*a* to 88*a*), the progress in stellar astronomy in 1911 is summed up on pages 88*a* to 173*a*; this is followed by a chapter by G. van Biesbroeck on "Calcul approché des Occultations." A complete list of the publications from the Royal Observatory of Belgium and an Index end the book.

This annual summary, by M. P. Stroobant, must involve a great deal of reading and work. It is a useful epitome, and would be rendered of even more use if a more detailed index were added.

F. A. B.

The Riddle of Mars, The Planet.—By C. E. HOUSDEN. 70 pages. 3 plates and other illustrations. $8\frac{1}{2}$-in. × $5\frac{1}{2}$-in.

(Longmans, Green & Co. Price 3/6 net.)

The author has worked out an ingenious scheme, from an engineering point of view, to explain the cause of the markings on Mars; with such a system of irrigation or conveyance of water from the melting polar caps—the Coolgardie system being a simile, the adaptation of the Martian method, or the converse—it is claimed that everything observed on Mars is satisfactorily accounted for. The arguments in support of his contentions are specious ones, and based on earthly suppositions. Chapter I relates to the colour changes observed on Mars; in Chapter II some comparison is made of the Earth with Mars; Chapters III to V explain how terrestrial engineers would plan the contract for the Martian water supply; Chapter VI deals with the horse-power required (about two thousand five hundred million horse-power, to be obtained from oil or the Sun); the seventh chapter sums up the author's conclusions: but the riddle remains unsolved. The book is well printed and illustrated. Speculative astronomy has its use in whiling away an hour or hours, whether of the author's or reader's time, but could not the time be far better spent? If some desire their imaginative powers livened up, books such as this may do it, and, if not producing any permanent good, are far less harmful than literary novels. Jules Verne's books no doubt served their purpose at the moment.

F. A. B.

CHEMISTRY.

Nucleïc Acids.—By W. JONES, PH.D. 118 pages. $9\frac{3}{4}$-in. × $6\frac{1}{2}$-in.

(Longmans, Green & Co. Price 3/6 net.)

This book follows the course of its predecessors in the series of monographs of bio-chemistry in aiming at a critical digest of researches on the subject that have appeared in scientific journals all over the world. Many of these are contradictory in their conclusions, and in such cases the author skilfully balances the evidence on each side. Much confusion with certain groups of proteins has grown up about the nucleïc acids, which are distinctive nitrogenous compounds contained in the nuclei of plant and animal cells, and in his opening chapter the author takes pains to show the points of relationship and difference between the two classes of bodies. In the first part of the book the chemical properties and derivatives of the nucleïc acids derived from thymus gland and from yeast cells are described, while the second part discusses the physiological properties (including their formation and decomposition in the organism) of the two classes of compounds. The outline of analytical methods and a good bibliography add greatly to the value of the monograph as a practical handbook in the laboratory.

C. A. M.

GEOGRAPHY.

Industrial and Commercial Geography.—By J. RUSSELL SMITH. 914 pages. 244 figures. $8\frac{1}{2}$-in. × 6-in.

(Constable & Co. Price 15/- net.)

The aim of this book is finely expressed in the first sentence of the preface. It is "to interpret the earth in terms of its usefulness to humanity." The book is divided into two parts, the first dealing with industry, the second with commerce, in relation to geographical conditions. The result has been to produce a volume of absorbing interest, not only in its subject-matter, but in the angle from which it views certain world-wide geographical relations, and the simple and charming style in which it is written. It is a book of a calibre and quality which lifts it high above the ruck of geographical works. The first part of the book is the longer, occupying more than two-thirds of its bulk. It treats each industry in turn, and explains its localisation and extent in relation to the environmental conditions. It exhibits the dependence of the various industries on climate, topography, and population, and shows how the tremendous expansion of our environment, effected by development of means of transport, has modified human activities. A typical instance of this is the abolition of the old "starving time" (April and May) in England, because we are no longer dependent on our own harvest to feed our people, but have food materials coming in abundantly from all parts of the world. The author leads us to hope that the food problem of the world will easily be solved by giving more scientific attention to the great undeveloped resources residing in its at present unused or little-used vegetable productions.

The latter third of the book shows that commerce depends on three factors: racial differences, differences in the stage of industrial development, and differences in the resources of the various lands. The last is the most important, since resources depend on topography, soil, moisture, nearness to sea, and temperature—factors independent of man. The differences arising from racial culture and the stage of

industrial development constantly tend to be levelled up amongst the various nations by the progressive equalisation of culture and trade. Further chapters describe and explain the location and origin of the trade routes of the world, the development of trade centres, the balance of trade in relation to industrial development, and the influence of geographical factors on the commercial policy of nations. The book, in fact, treats of the borderland between geography and economics, and leaves one with the impression that the "dismal science" must have greatly changed its character since the days of Ruskin. It is impossible to overpraise the care and thoroughness with which the work is done. It must have involved an enormous amount of delving into the little-worked mines of blue book literature and trade journalism. The publisher and printer are also to be congratulated on the excellent appearance of the book and its freedom from typographical errors.

G. W. T.

GEOLOGY.

Geological Excursions round London.—By G. Macdonald Davies, B.Sc., F.G.S. 156 pages. 4 plates. 20 figures. 1 map. 7½-in. × 5-in.

(T. Murby & Co. Price 3/6 net.)

London is not exactly an ideal centre for geological excursions. Natural exposures are rare, and the geologist has to depend on the chances of artificial exposures, which tend to be impermanent in the neighbourhood of a great city. Moreover, only Mesozoic and Kainozoic rocks are exposed within fifty miles of the city. Igneous rocks are absent, and the Palaeozoic floor is only accessible through deep borings. Hence the many geologists whose work centres in and about London are especially indebted to Mr. Davies for producing this handy work, which will enable them to employ their spare time to the best geological advantage. The description of twenty-six pleasant geological walks in the London basin, the Weald, and beyond the Chilterns, is prefaced by a concise account of the stratigraphical geology of the south-east of England. The descriptions are accompanied by sections and some excellent photographs. A geological map of the south-east of England, on the scale of about eighteen miles to the inch, is provided.

G. W. T.

MINERALOGY.

Minerals and the Microscope.—By H. G. Smith, A.R.C.S., B.Sc., F.G.S. 116 pages. 12 plates. 7½-in. × 5-in.

(T. Murby & Co. Price 3/6 net.)

This little book is intended to aid the beginner in microscopical petrography, and gives instruction in the use of the microscope, the recognition of minerals by means of their optical properties, and the use of these observations for the determination of rocks. The diagnostic characters of thin sections of minerals in ordinary transmitted light, in reflected light, with the lower Nicol inserted, and between crossed Nicols, both in parallel and in convergent polarised light, are described in as simple language as the technical character of the subject matter permits. The author has done remarkably well in achieving simplicity and lucidity in this difficult optical subject, notwithstanding great limitation in space and paucity of illustrations. He has omitted to state that in determining the angle of extinction the maximum value of readings made on several different crystals should be taken.

A useful synopsis of the microscopic characters of the common rock-forming minerals follows. The chapter describing methods of determining refractive index of isolated fragments might well have been expanded to deal with the characters of isolated mineral fragments in general, since, in the investigation of sands and clays, the clastic fragments appear to the student very different from the uniform thin sections with which he is accustomed to deal. The book closes with a brief chapter of hints on the microscopic characters of thin sections of rocks. This work will be of great use to students of elementary petrology, and its value is enhanced by an excellent series of photomicrographs of thin sections of minerals.

G. W. T.

SPINNING TOPS.

An Elementary Treatment of the Theory of Spinning Tops and Gyroscopic Motion. By Harold Crabtree, M.A. Second edition. 193 pages. 5 plates and numerous diagrams. 9¼-in. × 6-in.

(Longmans, Green & Co. Price 7/6 net.)

Ever since the appearance of Professor Perry's popular monograph on Spinning Tops opened the eyes of so many readers to the wealth of scientific import that underlies the principle of the favourite toy of childhood, it has been fully realised what an enormous field of interest and mystery the subject involves—a field covering alike the movements of solar systems, the revolutions of molecules, and probably the very qualities which constitute the apparent but questionable "solidity of matter." Mr. Crabtree's treatise, modestly called "an elementary treatment" of such phenomena, is therefore welcome as throwing considerable light on the seemingly paradoxical behaviour of spinning and gyrating bodies. The second edition contains additional articles on the practical applications of gyroscopic principles in the monorail cars of Brennan and Schilowsky, and also the gyro compass, a not less wonderful development of modern science. It need hardly be said that to an entirely unmathematical mind the mysteries of the spinning top must remain an insoluble problem, for there is no other way of elucidating them than by mathematical symbols; but by the aid of such equations, formulae, and graphic representations as are provided in these plainly written chapters an intelligent comprehension of the subject becomes possible to anyone who has had some training in elementary dynamics, while the introductory chapters, which make little demand upon the mathematical faculties, are in themselves full of fascinating interest to the less qualified reader. The whole subject is scientifically dealt with, and, at the same time, is lucidly expounded, with the aid of excellent plates and diagrams. A graceful sonnet to Dr. W. H. Besant at the commencement of the volume incidentally belies the notion that exact science and a true poetic sense are in any way incompatible.

C. E. B.

CORRESPONDENCE.

THE LONGEST DAY.

To the Editors of "Knowledge."

Sirs,—I shall feel obliged if you will kindly inform me which is the longest day of the year, June 21st or June 22nd, as there seems to be some uncertainty about it amongst a good many people.

Worthing. P. J. D.

If your correspondent wishes for the exact mathematical formula for the longest day it is:

When

$$\cos 15^\circ . t = -\tan l . \tan 23^\circ 28'.$$

t = the length of the morning (or evening).

l = the latitude of the place.

$23^\circ 28'$ = the Sun's greatest north declination or position in the heavens, *i.e.*, at the time of the summer solstice.

By changing the sign before the tan l the *shortest* day is determined.

In simpler form I will put it thus:

SUN ENTERS CANCER.

			h. m.	
*1908	......	June 21	8 19	=8 p.m.
1909	......	,, 21	14 6	=22nd, 2 a.m.
1910	......	,, 21	19 49	=22nd, 8 a.m.
1911	......	,, 22	1 35	=22nd, 2 p.m.
*1912	......	,, 21	7 17	=21st, 7 p.m.
1913	......	,, 21	13 9	=22nd 1 a.m.
1914	......	,, 21	18 55	=22nd, 7 a.m.
1915	......	,, 22	0 29	=22nd, noon.
*1916	......	,, 21	6 24	=21st, 6 p.m.

[The astronomical day begins at noon, and we run to 24h: a.m.'s and p.m.'s are a great nuisance.]

The year is 365¼ days long. Leap years come in for the odd hours once in four years. The Sun entering Cancer practically coincides with the Sun's great north declination; hence the longest day, which is at present nearly always on June 22nd. In Leap years it will thus be on June 21st, and may even (or in a few years' time) be on June 21st in the year *after* Leap years.

In nearly every book on astronomy published within the last seventy-five years, there is a singular absence of any direct reference to this expression, though the question has often been set in examination papers.

OXFORD. F. A. B.

NOTICES.

SECOND-HAND BOOKS.—A catalogue, issued by Messrs. W. Heffer & Son, of second-hand books consists of one hundred and eighty-six pages, of which several are devoted to books on Botany, Chemistry, Biology, and Zoölogy.

THE ZOÖLOGICAL SOCIETY.—The additions to the Zoölogical Society's menagerie during July were two hundred and seventy-seven in number, and included a Lesser Kudu (presented by Mr. Arnold Hodgson), a Cape Ant-bear (purchased), two Canadian Beavers (born in the menagerie), and several birds and lizards new to the collection.

BIRKBECK COLLEGE.—We welcome the appearance of the Calendar of the Birkbeck College, for session 1914–15, which contains particulars of all the classes and teaching staff in the faculties of Science, Arts, Laws, and Economics, as well as details of the various societies established in the College, and results of recent examinations.

THE IRISH NATURALIST.—The August and September issues of *The Irish Naturalist* have been combined to form a special double number to deal with "the Opisthobranch Fauna of the Shores and Shallow Waters of the County Dublin." The author gives sixty-nine species of the molluscs in question, including forty-five nudibranchs, or sea-slugs.

EXTENSION LECTURES.—Once more we welcome the issue by the Manchester Microscopical Society of the list of extension lectures which are voluntarily given by members of the Society. The Honorary Secretary is Mr. R. Howarth, of 90, George Street, Cheetham Hill, Manchester, from whom details of the sixty-nine subjects offered can be obtained.

CONTINUOUS CURRENT ELECTRIC MOTORS.—A new list has reached our hands which describes some of the latest designs of machines, from 1·65 to 54 brake horse-power, which are manufactured by Messrs. Crompton & Company. These motors are constructed with a very liberal rating, and have a low temperature rise, with high efficiency and large overload capacity. They are designed for driving all classes of industrial machinery, and the list includes pipe-ventilated and drip-proof machines for dusty, damp, or wet situations.

PETROLEUM.—Messrs. Crosby Lockwood & Son announce for publication in the autumn a new book on the "Chemistry of Petroleum and its Substitutes," by Drs. C. K. Tinkler and F. Challenger, of the University of Birmingham. The increasing importance of petroleum has necessitated thorough scientific training of those concerned with the industry, and hitherto there has been no suitable book combining some technological matter with the purely theoretical and practical organic chemistry necessary to a comprehension of the methods employed. It will be remembered that the University of Birmingham has instituted a three years' course in Petroleum Mining.

THE NEED FOR PLANT PROTECTION.—A correspondent of the Glasgow *Evening Citizen* writes as follows: "Gathering orchids seems to be a Sunday diversion in England in some places. On a recent Sunday in Holland's Wood, Brockenhurst, I met a man with a bouquet of the lesser butterfly orchis of anything up to a hundred of this beautiful and delicate species, and I saw another man engaged in a similar quest. Forest gypsies are adepts at this game, and to them it is a good source of profit. It is a deplorable state of affairs, which, it is to be hoped, will soon be remedied. Meantime, those who encourage the traffic are surely more blameworthy than the gypsies."

THE BRITISH ASSOCIATION.—It is announced that the following members are proceeding from Australia to England, via Suez Canal, by the P. & O. steamer "Malwa," which is expected to arrive in London on October 2nd: Mr. and Miss Beaven, Dr. C. I. and Mrs. Bond, Professor W. S. Boulton, Mr. and Miss Challenor, Dr. F. D. Chattaway, Professor F. J. Cole, Professor W. E. Dalby, Dr. W. H. Eccles, Mr. W. D. Eggar, Professor J. J. Findlay, Sir T. H. Holland, Dr. C. W. Kimmins, Mr. G. W. Lamplugh Mr. and Mrs. Laurie, Mr. F. S. Macauley, Professor B. Moore, Mr. R. B. Newton, Professor, Mrs., and Miss Poulton, Dr. A. O. Rankine, Professor T. B. Wood.

UNDERGRADUATES OF THE GLASGOW UNIVERSITY.—The Principal of the University of Glasgow asks us to convey to undergraduate students, called to active service for their country, the assurance that the University of Glasgow will do what it can to safeguard their academic interests. The authorities whom he has been able to consult agree with him in recommending that to such students every consideration should be extended which the Ordinances will permit. In relation to attendance at courses of instruction, to duration of study, to periods of notice required, and the like, account will be taken of a student's absence on military duty, so as, if possible, to ensure that his graduation shall not be unduly delayed.

NEW BOOKS.—In Messrs. Macmillan & Company's Autumn List, they announce the appearance of a life of Lord Avebury, by Horace Hutchinson. Under the heading of Anthropology is a General Index to Sir J. G. Frazer's "Golden Bough." We notice also "An Introduction to Field Archaeology, as illustrated by Hampshire," by Dr. J. P. Williams-Freeman, the first volume of "A Treatise on Embryology," edited by Walter Heape and written by Professor MacBride, "Stellar Movements and the Structure of the Universe," by Professor Eddington; and "Transpiration and the Ascent of Sap in Plants," by Professor Dixon.

In Messrs. Black's Autumn List we notice "Chemical Analysis," by George G. Gardiner; "Wireless Telegraphy," by A. B. Rolfe-Martin; and "Wild Life in Woods and Streams," by C. A. Palmer, to which the Rev. Charles A. Hall furnishes an Appendix on Mammals and Birds.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

NOVEMBER, 1914.

THE PLANET JUPITER.

By THE REV. THEODORE E. R. PHILLIPS, M.A., F.R.A.S.

THOUGH lacking in those special features which, in the popular view, invest Mars with such an atmosphere of romance, Jupiter, nevertheless, claims in an equal degree the close attention of telescopic observers. Indeed, to the amateur whose optical resources are usually of a modest nature, Jupiter affords a far more profitable field for work than Mars, whose small disc only now and again presents developments on a sufficiently large scale to be well within the grasp of small apertures. Such a development on Mars has occurred in recent years in the Nepenthes, L. Moeris, and Thoth region; but, broadly speaking, it may be said that, even in large instruments, the approximately stable features of the smaller and more condensed planet cannot, in the nature of things, present constant and unexpected changes, such as demand the watchful attention and assiduous work of the observer of Jupiter.

As regards physical condition, it has long been recognised that Jupiter has many points of analogy with the Sun. Its density is the same, and it is generally inferred that, like the Sun, it is in a heated and expanded condition, and that, if not still partially gaseous, it is, at any rate, in a viscous and semi-liquid state. Many features, too, of superficial resemblance have been pointed out by various investigators. To refer to two of the more striking and obvious instances, we may mention: (1) The analogy between the spot-zones on the Sun and the belts on Jupiter; and (2) the equatorial acceleration of both bodies.

As regards the first of these, it has been suggested by Lau (*Astron. Nachrichten*, Band 195, No. 4673) that the reason Jupiter has belts instead of zones of spots is to be found in its rapid rotation. The material forced upwards from the lower strata of the planet, bringing with it a smaller linear velocity than that of the surface, streams eastwards and assumes the appearance of elongated streaks. If the centres of eruption are sufficiently numerous, belts are formed; and it is suggested that, were the Sun's rotation much more rapid than it is, the solar surface at spot maximum would also present dark streaks or belts.

In accordance with this theory of belt formation it will be remembered that the great revival of Jupiter's north equatorial belt in 1912–13 began with the outbreak of a few isolated dark spots, which quickly spread out round the planet.

As regards the second of the analogies above-mentioned, it will be recalled that the rotation of the Sun can be fairly represented by a simple empirical formula, the velocity being related to the latitude and diminishing from the equator towards the poles. Now Cassini, in 1690, found that a spot on the equator of Jupiter required about five minutes or so less for a rotation than an object in the southern hemisphere; and subsequent observations have established the existence of

a rapid equatorial current as a permanent feature of the visible surface of the planet. It is true that the cases of Jupiter and the Sun are not quite the same; on the former there is no general increase in the rotation period with increasing latitude, but a sudden and abrupt change in the velocity in both hemispheres at about latitude seven degrees. The equatorial current of Jupiter is therefore like a mighty river sharply bounded by two banks which are usually indicated by the two great equatorial belts.* Beyond these the arrangement of the currents is unsymmetrical and dissimilar in the two hemispheres; but, notwithstanding these differences, the analogy between the equatorial accelerations of the Sun and Jupiter is very striking, and it is hardly possible to doubt that the cause in each case is the same.

It is not intended in this article to discuss in any detail the physics of Jupiter, but the analogy, to which attention has been drawn between the planet and the Sun, suggests certain possible explanations of some of the planet's phenomena.

(*a*) It has been found that certain sunspots appear to be vortices, and exhibit a whirling motion. It is suggested that many of the Jovian spots are of the same nature, and are the results of disturbances whose origins lie at some depth below the superficial layers. Kritzinger (see *B.A.A. Journal*, Vol. XXIV, No. 9) thinks it probable that, in accordance with Emden's theory of the sunspot zones, a number of discontinuous surfaces are developed within the planet, and that the edges of these different surfaces at the boundary of the disc produce the belts. The effect of two terrestrial atmospheric layers of different density, with one gliding over the other, in producing clouds of the cirro-cumulus type is well known, and it is hinted that the Jovian spots have an analogous formation. Lau also (*Astron. Nachrichten*, Band 195, No. 4673) considers that vortices are formed along the line of contact between the great equatorial current and the slower moving material north and south.

It is now very generally held that the Great Red Spot is a vortex. That it is not a solid feature of the planet is proved by its extensive wanderings, but at least it is sub-permanent, and has indicated a centre of disturbance which has existed certainly for over eighty years, as Denning and Kritzinger have independently shown, and probably for over two hundred and fifty years. The idea that the Red Spot is a vortex is well supported by the behaviour of the dark material forming the South Tropical Disturbance, or "Schleier," which has been so prominent a feature of the disc during the last thirteen years. Six times has the Disturbance, which is situated in the same latitude as the Red Spot, overtaken the latter, and its behaviour at such times, though still in some respects mysterious, is nevertheless instructive. Now it has been observed that, as the *p* end of the Disturbance approaches the *f* "shoulder" of the hollow, it becomes accelerated, but that after its appearance west of the *p* "shoulder" it is retarded. The same thing is true of the *f* end. This is strongly suggestive that the Red Spot is a centre of attraction, a vortex which draws into itself the surrounding material. It is, however, not certain at what level the Disturbance moves. Lau considers that it passes under the white material overlying the Red Spot, and certainly little or no trace of it is seen during its passage across the bay. On the other hand, the outline of the Spot itself has sometimes been faintly discerned during conjunction, which suggests that the dark matter is mostly whirled round the periphery of the vortex and passes out on the *p* side. It has been observed that the time occupied in passing from the *f* to the *p* "shoulder" by the ends of the Disturbance is very decidedly shorter than the time usually required to move over the same distance elsewhere. The vortex theory also explains the formation of the bay, or hollow, in which the Red Spot lies; since the drawing in of matter towards the centre at the lower levels must be accompanied by an outward flow at a greater altitude. This latter may very well drive back the material of the south equatorial belt, and consequently give rise to the formation of the well-known bay at its south edge.

(*b*) The equatorial acceleration of Jupiter, like that of the Sun, presents an interesting problem. Lau, in his article above referred to, speaks of it as a survival from an earlier condition of things, and apparently considers that it has its origin in the falling in of particles possessing a greater angular velocity than the planet itself. Whether the combined momentum of such particles would be sufficient now to produce an appreciable effect may be questioned; but, if the masses of the planets and the Sun have been in the past much increased by the accretion of meteoric dust particles revolving in direct orbits, the tendency would certainly have been to produce an accelerated superficial equatorial motion. A simple calculation shows that particles revolving close to the Sun's surface would perform a revolution in, roughly, three hours, whereas the Sun itself requires for a rotation at least twenty-five days. For particles one hundred miles above the present surface of Jupiter, and spots on the Jovian equator, the corresponding times are 2h 57m and 9h 50m respectively. The same kind of thing is true of Saturn; and it seems quite possible that we have here, at any rate, one factor in the production of the equatorial acceleration exhibited by the larger bodies of the solar system.

A point which has attracted the close attention of observers of Jupiter is the variation in the

* The southern line of demarcation is usually between the two components of the south equatorial belt. In the northern hemisphere it is commonly at the north edge of the north equatorial belt, though when that belt is broad and double it often lies between the two components.

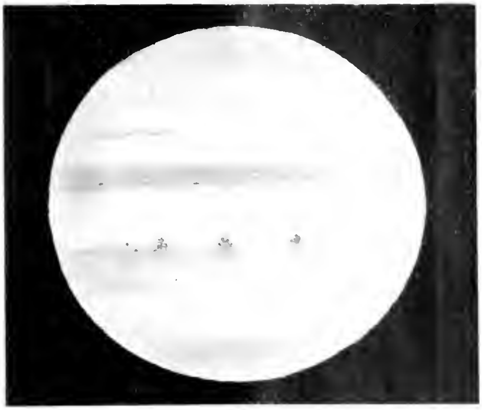
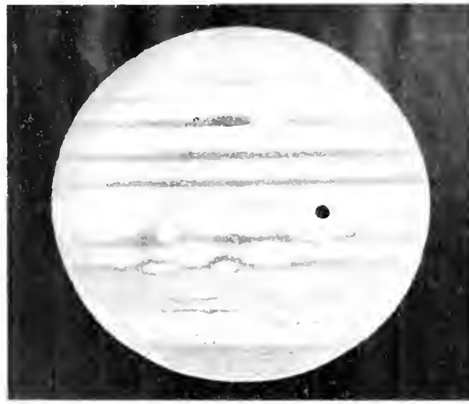


Figure 36[illegible]. July 24, 191[illegible]. [illegible]



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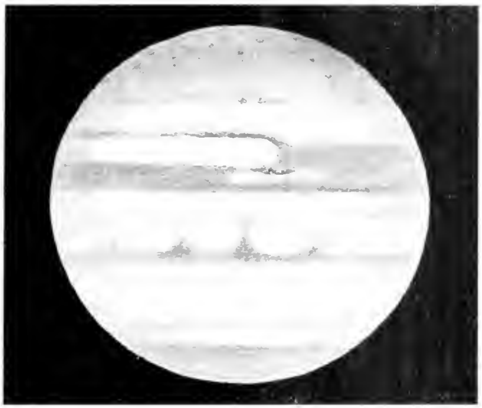
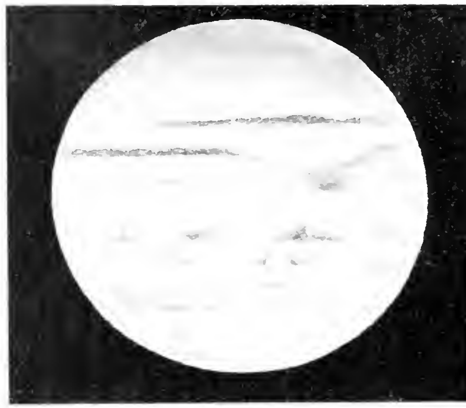


Figure 364. August 28, [illegible]



F[illegible] 1914. [illegible]

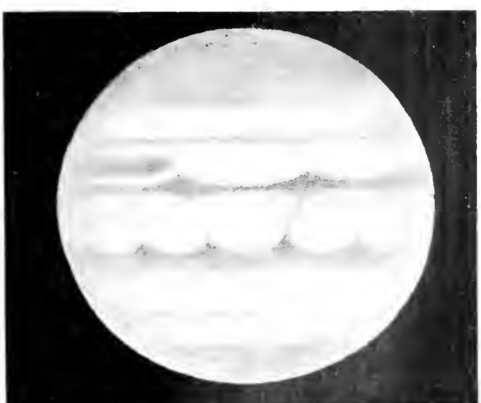


Figure 365. Septe[illegible]

[illegible]

The planet Jupit[illegible] as [illegible] in an In[illegible]

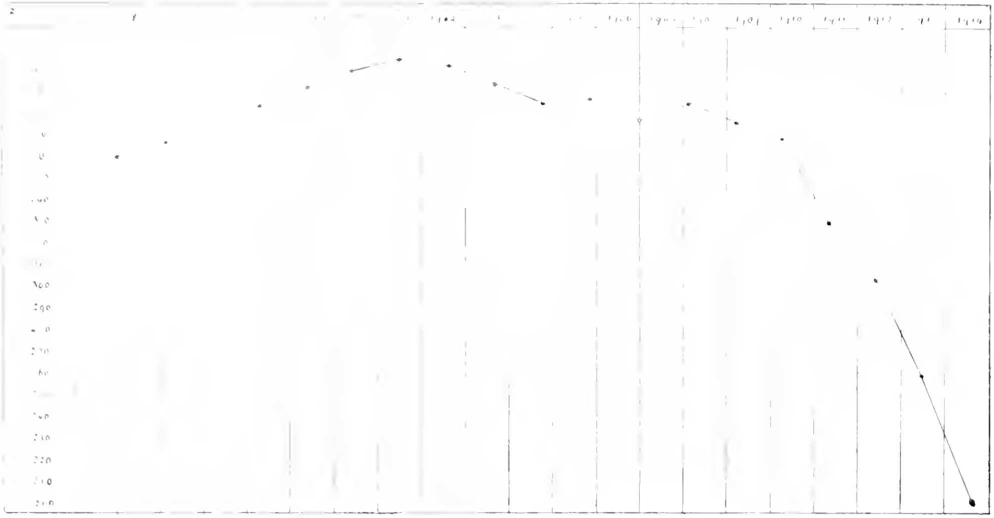


FIGURE 369.

Position of Red Spot at opposition, 1894 to 1914.

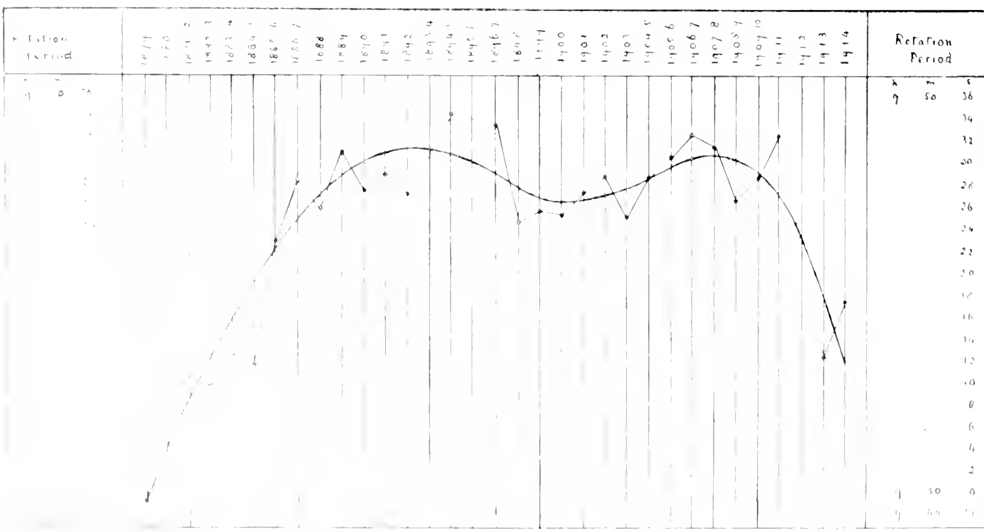


FIGURE 370.

Rotation Period of Equatorial Current, 1879 to 1914.

[illegible] 1914 [illegible] observations [illegible] May to August only.

velocity of different parts of the disc. Separate and distinct currents in the surface material of the planet whose latitudinal limits show only small changes have for several years been recognised, but their rates of motion are found to be variable. The drift of spots differs slightly from year to year, and there is reason to suppose that in some instances the variations in velocity are of a periodic nature, with minor fluctuations superposed on longer waves of considerable amplitude. Something of this kind seems probable in the cases of the Red Spot * and the great equatorial current. The motion of the former has been thoroughly discussed by Denning and by Kritzinger independently, and a period of, roughly, fifty years has been suggested. Figure 369 shows the changes in the position of the Red Spot during the last twenty years. It will be seen that since 1901 the longitude has diminished by well over two hundred degrees. The rotation period attained a maximum value of 9h 55m 42s ± in 1899, but in the year 1913–14 (from opposition to opposition) this had become reduced to 9h 55m 35s ±.

Figure 370 shows the changes in the rotation period of the great equatorial current since 1879. The diagram is based on weighted values derived from the results of various observers (cf. papers by A. S. Williams, *M.N.*, Volume LXIII, page 14, Volume LX, page 465, Volume LXXI, page 145; W. F. Denning, *M.N.*, Volume LXIII, page 331; Major P. B. Molesworth, *M.N.*, Volume LXV, page 691, and so on), B.A.A. Jupiter Section Memoirs, and so on; and shows that the rotation period in 1913 was practically the same as it had been thirty years earlier. The curve exhibits a slight secondary minimum about 1900, which gives it some resemblance to the light-curves of variable stars of the β Lyrae type; but observations extending over a much longer period are needed to show whether or not the changes are definitely periodic.

Some reference to the present appearance of the planet may be of interest. A comparison of the drawings of 1913 (see Figures 363, 364, and 365) with those of the current apparition shows that considerable changes have been in progress, and illustrates those characteristics of the surface markings which render Jupiter so attractive an object for telescopic scrutiny. It will be seen from Figure 367 that the South Tropical Disturbance is now clear of the Red Spot hollow, having just completed its sixth conjunction with that object, and that the Red Spot itself has once more emerged as a well-defined ellipse. To the writer, however, it shows no trace of red, but is neutral grey, presenting a striking contrast to the warm tone of the south equatorial belt. The longitude (ω_2) of the Red Spot at the end of August was about 202°. The South Tropical Disturbance now extends over 110° ± in longitude; the positions (ω_2) determined at Ashtead at the close of August being: Preceding end, 62° ±; following end, 173° ±.

It will be seen that marked changes have occurred in the north equatorial, north tropical, and north temperate regions of the planet. The brilliant egg-shaped markings which in 1913 formed a belt round the north part of the equatorial zone have become degraded into smaller and less regular white areas, whilst the dark protuberances are also very unequal in size, shape, and distance apart. Observations of thirteen north equatorial markings down to the end of August give a mean rotation-period of 9h 50m 17s·4, which is a slight increase on the value of last year.

Amongst recent developments must be mentioned the formation of dark spots on the north component of the north equatorial belt with white intermediate areas (some of them very bright) on the region between the two components of the belt. Still more interesting is the form assumed by some of the dark markings. They are distinctly arched to the south, and enclose small brilliant white spots, the appearance being suggestive of bridges, or sometimes links of a chain. At least seven objects are of this character, and an idea of their strange form may be gained from Figures 366 and 367. Observations of seventeen objects in this region show the rotation-period down to the end of August to have been 9h 55m 30s·6.

Another striking difference between the appearance of the planet in 1913 and 1914 is furnished by the south equatorial belt. Almost uniformly dark in the former year, it has recently consisted of two widely separated bands with a pale orange region between them.

* Some of the irregularities in the motion of the Red Spot have been associated with its conjunctions with the South Tropical Disturbance. During conjunction the motion becomes accelerated.

FLORA SELBORNIENSIS.

November, 11th Month (*continued*).

19. The Bat mentioned is probably *Vesperugo pipistrellus*; the Dor-beetle is *Geotrupis stercorarius*. Of the fishes, the Bull's Head is *Cottus gobio*; the Eel, *Anguilla anguilla*; the Trout, *Salmo fario*; and the Stickleback, *Gasterosteus aculeatus*.

December, 12th Month.

8. The Flesh-fly is now *Sarcophaga carnaria* and the Song Thrush, *Turdus musicus*.

ERRATUM. October 17th.—Barometer reading, 30·0 inches should be 30·40 inches

61.

Novemb: 14. The wood-lark, Alauda sylves:
& the skie-lark, Alauda vulg: sing.
Flies appear still in numbers.
The Ground is now thoro'ly soaked.
16. The ripe berries of the yew-tree fall.
17:18. Tempestuous winds.
19. The bat, vespertilio, appears.
The common dor, or clock, scarabæus magnus
niger vulgatissimus, is seen flying.
Fishes in the Rivulets at Selborne are the
Bull's head, or Miller's thumb: Gobius fluviatilis
capitatus: the trout, Trutta fluviatilis: the eel,
Anguilla, the ~~[illegible]~~ lampern, lampetra parva & fluviatilis; ~~[illegible]~~, ~~the minnow~~
~~[illegible]~~ pisciculus aculeatus, x
Decem: 8. Delicate weather: the air is full of
gnats, & the ground covered with spider's-webs:
the flesh fly, musca carnaria, appears in numbers.
The song-thrush, turdus simpliciter dictus, sings.

x stickleback.

SOME INTERESTING FEATURES OF PHOTO-CHEMISTRY.

By H. H. McHENRY.

The subject of Photo-chemistry is one about which comparatively little is known. While the applications to ordinary photography are well understood, the theory that leads to the chemical action of light is far from being perfectly comprehended.

The photo-chemical process has two phases. The production of a compound is one phase, such as the production of chlorine knall-gas. The other is decomposition, such as the decomposition of hydrogen phosphide with separation of phosphorus. This latter phase is by far the more common. The chemical action of sunlight, such as that shown in the bleaching process, the production of green colours in plants, and the well-known action of light used for blue-printing, have been known for centuries. Only recent investigations, however, have taught us that numerous compounds are sensitive to light, and convinced us that here we are dealing with a mutual action between ether vibrations and chemical forces. By experiment it is found that the chemical action of light takes place only in special cases, as it is held that illumination can exert an influence on the reäction velocity of a system which is in the process of change, or on a system in the state of equilibrium which is in chemical repose.

Before discussing the theory of the ether vibrations, it might be well to cite a few features of ordinary photography. The modern chemical method employed in development rests on what is known as the "latent light-action of the silver salts." A gelatine film impregnated with silver bromide is first illuminated and then treated with reducing agents. The silver haloid in the plate is then reduced to silver most quickly. At the illuminated spots this reduction results in the formation of free halogen, but the nature of the reduction product is not known in all cases. On the illuminated spots of the plate small particles of metallic silver are deposited by reduction, their density increasing with the intensity of light, but always in such small quantities that no visible change occurs in the substance of the plate. When the plate is put into the developer, those invisible silver particles act as nuclei for the precipitation of silver, just as small crystals bring about crystallisation in a super-saturated solution. The denser the silver particles at any spot, the denser will be the deposit of silver during development.

A valuable aid to photography was furnished in a discovery made by Vogel in 1878. He found that photographic plates may be made more sensitive by intermixture with slight traces of organic colouring substances. Also the plates are usually especially sensitive for kinds of light absorbed by particular colouring substances. Thus plates may be prepared sensitive to yellow, blue, or red, or any coloured light. This phenomenon is called optical sensitation. So far no theoretical explanation has been given for it.

As light is thought to be a phenomenon occasioned by ether vibrations, the theoretical consideration of its chemical effects must lie with these vibrations. When ether vibrations traverse a material system, they occasion two different results. Firstly, they raise the temperature of the system, their energy being partly converted into heat. Secondly, they occasion chemical changes, occurring at the expense of some of the energy of vibration. The first phenomenon is known as the absorption of light, the second as the photo-chemical absorption of light. Gases, liquids, and solids all respond to ether vibrations, such as the explosive mixture of hydrogen and chlorine, chlorine water, which gives up oxygen under the influence of light, and white phosphorus, which changes to the red modification, in light, or cinnabar, which turns black. While photo-chemical action may be produced by any type of ray, it depends on the wave-length of the light used, like ordinary absorption.

A set of empirical laws of photo-chemical action, compiled by Eder, serves as an aid to understand the chemical action of light-rays. They are: (1) Light of every wave-length is capable of photo-chemical action. (2) Only those rays are effective which are absorbed by the system, so that the chemical action of light is closely associated with optical absorption, although the converse is not true. (3) According to the nature of the substance absorbing light, every kind of light may act in an oxidising or reducing way. The red light has an oxidising effect, and violet light a reducing effect on the metals. (4) Not only the absorption of light-rays by the illuminated substance itself plays an important part, but also the absorption of light by a foreign substance mixed with the principal substance, for the sensitiveness can be stimulated for these rays which are absorbed by the admixed substance. (5) A substance sensitive to light, admixed with the main substance, and which unites with one of the products resulting from photo-chemical action (as oxygen, bromine, or iodine), tends to accelerate the reäction velocity to such an extent that reversal is impossible. This may be regarded as a consequence from the law of mass action.

As stated above, these laws can only be regarded as empirical. There are some exceptions, notably, to (3). Red light exerts a reducing effect in the case of the latent light-action of the silver salts, while violet oxidises organic compounds, especially colourless ones. These laws were ascertained by means of instruments known as actinometers, which measure the intensity of the chemically active rays. The idea of actinometers is a most important one. All pieces of apparatus which are designed to measure this intensity, and which collectively depend upon the observed changes which are experienced by substances sensitive to light when under the influence of ether vibrations, are called actinometers. The data obtained from actinometers of all kinds must be considered as having a purely individual nature. They give only a *relative* measurement of the intensity, for if the same kind of light is used, the nature and reäction velocity of the chemical process occasioned in each case will vary according to the behaviour of the system which is subjected to the action of light. Also, when the light used consists of rays of different wave-length, the data of the same actinometer will by no means be proportional to the intensity of light, as the action of light varies greatly according to its wave-length.

It might be well here to consider a few types of actinometers. The eye can be considered an actinometer, because, apparently, its sensitiveness to ether vibrations depends upon certain photo-chemical processes which are thereby occasioned. However, the results of visual photometric measurement are not parallel with those obtained by actinometers, and neither results are parallel to those obtained by thermometric measurements. The latter is usually regarded as an absolute measure of radiation. It would perhaps be more correct to regard the diminution of free energy, which is unknown, associated with the change of radiant energy into heat, as the measure of the intensity of light.

A simple form of actinometer is that known as the chlorine knall-gas actinometer. It depends on a discovery of Gay-Lussac and Thénard in 1809, who found that, when strong light acted on the combining of chlorine and hydrogen, the velocity increased rapidly to the point of explosion, and, when weak light acted, it progressed slowly and steadily. The method consists in measuring the diminution of a volume of chlorine knall-gas (standing over water, and maintained at constant pressure and volume) as a result of the formation of hydrochloric acid, which is absorbed by the water. This actinometer was constructed by Draper in 1843, and, later, improved by Bunsen and Roscoe.

These two men discovered the silver-chloride actinometer, in which the time required to darken a photographic paper until a definite " normal " shade is reached is taken as a measure of light-intensity.

Another interesting actinometer is the electro-chemical actinometer. Two silver electrodes, which have been chlorinised or iodised, are dipped into a dilute solution of sulphuric acid. Electromotive force will be established between the electrodes, and as long as one of them is illuminated the current will flow in the solution from the unlighted to the lighted pole. The strength of the current is read by means of a sensitive galvanometer, and this serves to determine the intensity of the light. Results obtained by this actinometer agree approximately with those obtained in photometric ways. This actinometer was constructed by Becquerel in 1839.

Attention may now be turned to the work performed by chemically active light. One would expect the light to be absorbed to a greater degree when it occasions, or accelerates, a chemical process than when such is not the case. Bunsen and Roscoe found that when light passed through a layer of chlorine knall-gas it was much more weakened in its chemical activity than when it passed through chlorine alone. In both cases the light is weakened by absorption by the chlorine: the absorption by the hydrogen can be neglected. But in the first instance, absorption is purely due to optical activity, and, therefore, the loss of energy reäppears in the heat developed. In the second case, however, an additional fraction of light-energy is consumed in performing chemical work, which thus occasions a stronger absorption. This phenomenon is called photo-chemical extinction.

A word may be said as to the speed of chemical light-action. Bunsen and Roscoe found that light usually acts very slowly at first, and only attains its full activity after a lapse of time. This is called photo-chemical induction. Pringsheim succeeded in showing that this phenomenon is due to the formation of intermediate compounds. As chlorine knall-gas is more sensitive to light when moist than when dry, it seems probable that hydrogen and chlorine do not unite directly to form the acid, but that a series of intermediate compounds is first formed. Also a slight preliminary exposure of a photographic plate renders it more sensitive, and an under-exposed plate is strengthened by a subsequent exposure.

The physical laws which chemically active photographic rays obey are of peculiar interest. They are reflected, refracted, and polarised like other rays, their intensity diminishing as the reciprocal of the square of the distance from the point of origin. Research work has shown that when light of the same kind is used, the photo-chemical action depends solely on the product of the intensity and the duration of exposure. It has also been proved beyond doubt that the time required for the development of a normal colour on sensitive paper is proportional to the number of light-waves which strike the paper per second.

One important difference between photo-chemical reäctions and ordinary reäctions is that the velocity in the former increases but little in a rise of

temperature, while that of the latter increases enormously. We are led to believe that light-action should not be regarded as a direct loosening of the atoms in a molecule such as that effected by heating, but rather the primary effect must be some action on the luminiferous ether, and suggests ionisation.

Now what is the cause of these light-vibrations? The latest authorities maintain that light-vibrations are produced by electric agitations, and that in the chemical action of light we deal with phenomena not far removed from the formation and decomposition of compounds under the influence of the galvanic current. That chemical equilibrium is affected by illumination follows from the change in the thermodynamic potential of components by illumination, as may be more clearly deduced from the electro-magnetic theory of light. It has been proved that electrification and magnetism alter the thermodynamic potential, and the action of light-waves is, according to the most advanced theories, that of rapidly alternating electric fields. From these conclusions we may assume, at least until further knowledge of the subject is gained, that the ultimate cause of the photo-chemical action of light lies in electric phenomena.

SOLAR DISTURBANCES DURING SEPTEMBER, 1914.

By FRANK C. DENNETT.

The Sun was observed every day during September. On one day only (7th) did the disc appear free from disturbance, but on the six previous days only faculae were visible. Spots were visible on and after the 8th until the month ended. The longitude of the central meridian at noon on September 1st was 259° 53′.

No. 28.—A spot, some eighteen thousand miles in diameter, had come round the south-eastern limb on the 8th, its umbra being comparatively small. From the 10th until the 17th much change took place in the form of the umbra. There was a pore a little north of east on the 13th, and two south-east on the 15th. It was shrinking on the 18th, and was last seen near the south-western limb on the 20th. On the 12th, 15th, 17th, and 19th the penumbra seemed to brighten inwardly.

No. 29.—This appears to be a return of No. 24, very little decreased in size, first seen on September 9th. On the 10th the inner edge of the penumbra was noted as brighter. Little bright tongues penetrated the northern edge of the umbra on the 13th and 16th. On the 17th the southern part of the umbra was darkest. After the 18th the umbra was cut into two by a bright bridge, and on the 20th the penumbra increased to northward. It was last seen on the 22nd. Both near the following and preceding limb, it was seen to be accompanied by a great amount of faculae, extending so far as 31° N. A tiny pore was close to its northern edge on the 13th and 16th, two others near its south-eastern border on the 16th, and next day one to the east and another south-east.

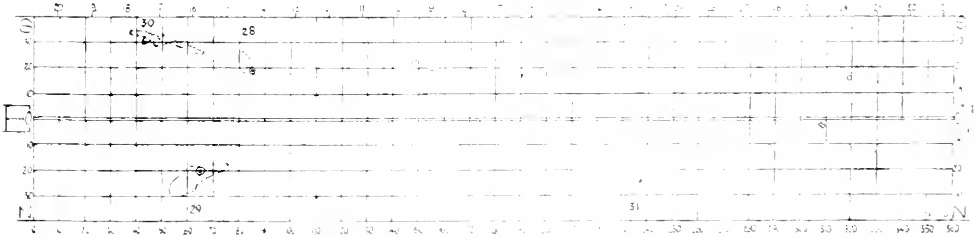
No. 30.—What appeared as a large spot appeared close to the south-eastern limb on September 11th, preceded by faculae, was seen next day to be two spots. On the 13th there was a pore some 8° ahead; this had gone next day, when there was a comma-shaped spot with a pore away to the east. On the 15th the comma formed the eastern extremity of an ellipse, outlined with pores, having a major axis some 6° in length. The tail broke off on the 16th, and was widely separated on the 17th, when last seen, the region being marked by faculae as it drew near the south-western limb from the 20th until the 23rd. Its greatest diameter was fifteen thousand miles.

No. 31.—On the 23rd a spot nine thousand miles in diameter came into view close to the north-eastern limb. A pore was seen close to it next day, but not observed after. On the 25th the inner border of the penumbra was brightly fringed, and next day the umbra was divided by a bridge. On the 29th and 30th the umbra was broken into four parts, and on October 1st the penumbra seemed gone. Nothing more was seen of the spot after.

Faculae were recorded near the western limb (308°, 2° N.) on September 30th; near the north-western, September 1st to 3rd; near the north-eastern, September 3rd and 30th (163°, 31° N.); on the south-western, September 1st (319°, 16° S.), 14th, and 19th till 23rd, the remains of No. 30; and near the south-eastern on 1st (182°, 30° S.), 2nd, 3rd, 4th (155°, 19°, and 149°, 22° S.), 5th, 8th, 11th, and 14th (27°, 27° S.). Little facule knots were observed near the North Pole on September 22nd, 23rd, 25th, 26th, and 30th.

Our chart is constructed from the combined observations of Messrs. J. McHarg, E. E. Peacock, J. C. Simpson, and F. C. Dennett.

DAY OF SEPTEMBER, 1914.



THE FACE OF THE SKY FOR DECEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 50.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Vesta. R.A.	Vesta. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Dec. 4	16 30·0	S.22·2	0 3·0	N.27·7	15 30·3	S.17·5	15 54·3	S.20·4	5 2·1	N.17·1	21 20·1	S.16·5	6 0·0	N.22·3	8 9·2	N.19·7
,, 9	17 1·7	22·8	10 24·4	N. 0·5	16 0·1	19·7	15 46·2	18·7	4 56·6	17·2	21 23·3	16·3	5 59·2	22·3	8 8·8	19·8
,, 14	17 23·7	23·2	14 44·7	S. 21·1	16 31·5	21·7	15 42·0	17·4	4 51·1	17·3	21 26·8	16·0	5 57·5	22·3	8 8·4	19·8
,, 19	17 45·6	23·4	20 0·0	S. 22·8	17 4·1	23·2	15 41·8	16·0	4 45·8	17·4	21 30·4	15·7	5 55·7	22·3	8 8·0	19·8
,, 24	18 8·1	23·4	0 8·2	N. 4·1	17 37·8	24·2	15 45·4	16·1	4 40·0	17·5	21 34·2	15·4	5 53·9	22·3	8 7·5	19·8
,, 29	18 30·3	S.23·3	3 50·7	N.25·8	18 12·2	S.24·8	15 52·3	S.16·0	4 30·5	N.17·6	21 38·1	S.15·1	5 52·2	N.22·3	8 7·0	N.19·9

TABLE 51.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
Dec. 4	15·1	+0·4	99·9	− 0·4	−19·8	+0·2	115·2	306·3	6 42 *e*	11 25 *e*
,, 9	13·0	−0·3	34·0	+19·8	20·0	0·2	183·5	336·5	4 50 *e*	10 35 *e*
,, 14	10·8	0·9	328·2	+17·1	20·2	0·3	251·8	6·6	2 58 *e*	9 46 *e*
,, 19	8·5	1·5	262·3	−10·8	20·5	0·3	320·0	36·7	10 57 *e*	8 56 *e*
,, 24	6·1	2·1	196·4	−22·2	20·7	0·3	28·3	66·8	9 5 *e*	8 6 *e*
,, 29	+ 3·7	−2·8	130·6	−11·6	−21·0	+0·3	96·5	96·9	7 13 *e*	7 16 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc. apply to T_1, T_2 multiples of $9^h\ 50^m·7$, $9^h\ 55^m·8$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN passes the Winter Solstice $22^d\ 4^h$ *e*. Its semi-diameter increases from 16′ 15″ to 16′ 18″. Sunrise changes from $7^h\ 44^m$ to $8^h\ 8^m$; sunset from $3^h\ 53^m$ to $3^h\ 58^m$.

MERCURY is a morning star. Semi-diameter diminishes from 3″ to 2½″. Illumination increases from $\frac{8}{10}$ to Full. 21′ North of Venus $7^d\ 3^h$ *e*.

VENUS is a morning star, stationary on 17th. Illumination increases from zero to ¼. Semi-diameter diminishes from 32″ to 21″.

THE MOON.—Full $2^d\ 6^h\ 21^m$ *e*. Last quarter $10^d\ 11^h\ 32^m$ *m*. New $17^d\ 2^h\ 35^m$ *m*. First quarter $24^d\ 8^h\ 25^m$ *m*. Perigee $15^d\ 2^h$ *e*. Apogee $27^d\ 1^h$ *e*, semi-diameter 16′ 36″, 14′ 46″ respectively. Maximum librations 1^d 7° S., 9^d 6° E., 15^d 7° N., 21^d 7° W., 29^d 7° S. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 52).

MARS is invisible; in conjunction with Sun on 24th.

JUPITER is an evening star, in Capricornus, 28′ North of ι Capricorni November 30th. Polar semi-diameter 17″; near Moon on 21st.

Configuration of satellites at $5^h\ 30^m$ *e* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.		East.	Day.	West.		East.
Dec. 1	2	○	134	Dec. 17		○	1234
,, 2	21	○	34	,, 18	1	○	324
,, 3		○	1234	,, 19	32	○	14
,, 4	1	⊙	24	,, 20	312	○	4
,, 5	32	○	14	,, 21	3	○	124
,, 6	341	○	2●	,, 22	1	⊙	34
,, 7	43	⊙	2	,, 23	24	⊙	3
,, 8	42	○	3 1●	,, 24	4	○	213
,, 9	421	○	3	,, 25	41	○	32
,, 10	4	○	123	,, 26	43	○	1
,, 11	41	○	32	,, 27	4312	○	
,, 12	43	○	1	,, 28	43	○	12
,, 13	3412	○		,, 29	413	○	2
,, 14	3	○	12 4●	,, 30	24	○	13
,, 15	2	○	34 1●	,, 31		○	43 1●2●
,, 16	21	○	34				

The following satellite phenomena are visible at

Greenwich, all in the evening:—$4^d\ 6^h\ 12^m\ 13^s$ III. Tr. E., $7^h\ 20^m\ 20^s$ III. Sh. I.; $6^d\ 4^h\ 15^m\ 54^s$ II. Oc. D., $5^h\ 40^m\ 24^s$ IV. Sh. I., $7^h\ 50^m\ 5^s$ I. Oc. D.; $7^d\ 5^h\ 2^m\ 6^s$ I. Tr. I., $6^h\ 12^m\ 56^s$ I. Sh. I., $7^h\ 20^m\ 2^s$ I. Tr. E., $8^h\ 30^m\ 30^s$ I. Sh. E.; $8^d\ 4^h\ 20^m\ 54^s$ II. Sh. E., $5^h\ 46^m\ 56^s$ I. Ec. R.; $11^d\ 6^h\ 52^m\ 0^s$ III. Tr. I.; $13^d\ 7^h\ 2^m\ 53^s$ II. Oc. D.; $14^d\ 7^h\ 2^m\ 2^s$ I. Tr. I., $8^h\ 3^m\ 5^s$ IV. Oc. R., $8^h\ 8^m\ 47^s$ I. Sh. I.; $15^d\ 4^h\ 7^m\ 53^s$ II. Sh. I.; $4^h\ 19^m\ 22^s$ I. Oc. D., $4^h\ 46^m\ 52^s$ II. Tr. E., $5^h\ 15^m\ 44^s$ III. Ec. R., $6^h\ 56^m\ 37^s$ II. Sh. E., $7^h\ 42^m\ 5^s$ I. Ec. R., $3^h\ 50^m\ 14^s$ I. Tr. E., $4^h\ 55^m\ 34^s$ I. Sh. E.; $22^d\ 4^h\ 42^m\ 52^s$ II. Tr. I., $5^h\ 0^m\ 27^s$ III. Oc. R., $5^h\ 40^m\ 32^s$ III. Ec. D., $6^h\ 19^m\ 25^s$ I. Oc. D., $6^h\ 43^m\ 33^s$ II. Sh. I., $7^h\ 32^m\ 12^s$ II. Tr. E.; $23^d\ 4^h\ 33^m\ 31^s$ I. Sh. I., $4^h\ 41^m\ 34^s$ IV. Sh. E., $5^h\ 51^m\ 3^s$ I. Tr. E., $6^h\ 51^m\ 29^s$ I. Sh. E.; $24^d\ 4^h\ 5^m\ 54^s$ I. Ec. R., $4^h\ 15^m\ 22^s$ II. Ec. R.; $29^d\ 5^h\ 54^m\ 41^s$ III. Oc. D., $7^h\ 20^m\ 10^s$ II. Tr. I.; $30^d\ 5^h\ 34^m\ 2^s$ I. Tr. I., $6^h\ 29^m\ 15^s$ I. Sh. I.; $31^d\ 4^h\ 12^m\ 3^s$ IV. Oc. R., $6^h\ 0^m\ 54^s$ I. Ec. R., $6^h\ 53^m\ 52^s$ II. Ec. R.

Eclipses will take place to the right of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN is in opposition on 21st, in Gemini. Polar semi-diameter $9\frac{3}{4}''$. Major axis of ring $48''$, minor $21\frac{1}{2}''$. Angle $P - 6^\circ{\cdot}0$.

Eastern elongations of Tethys (every 4th given) $8^d\ 9^h{\cdot}7$ *m*, $15^d\ 10^h{\cdot}9$ *e*, 23^d Noon, $31^d\ 1^h{\cdot}2$ *m*; of Dione (every 3rd given) $2^d\ 3^h{\cdot}8$ *e*, $10^d\ 8^h{\cdot}7$ *e*, $19^d\ 1^h{\cdot}7$ *m*, $27^d\ 6^h{\cdot}7$ *m*; of Rhea (every 2nd given) $7^d\ 3^h{\cdot}8$ *m*, $16^d\ 4^h{\cdot}4$ *m*, $25^d\ 5^h{\cdot}1$ *m*.

For Titan and Japetus E., W. stand for East and West elongations, I. for Inferior (North) conjunction, S. for Superior (South) conjunction. Titan $2^d\ 11^h{\cdot}0$ *e* E., $6^d\ 0^h{\cdot}8$ *e* I., $10^d\ 6^h{\cdot}3$ *e* W., $14^d\ 6^h{\cdot}3$ *e* S., $18^d\ 8^h{\cdot}6$ *e* E., 22^d [illegible]$\cdot 2$ *e* I., $26^d\ 3^h{\cdot}9$ *e* W., [illegible] $3^h{\cdot}8$ *e* S.; Japetus $12^d\ 5^h{\cdot}5$ *e* W., $31^d\ 2^h{\cdot}9$ *e* S.

URANUS is an evening star in Capricornus, 1° North of Moon on 20th, R.A. $20^h\ 47^m$ S. Dec. $18^\circ{\cdot}6$.

NEPTUNE is a morning star, coming into a better position for observation. $2\frac{1}{2}^\circ$ S. of Moon on 6th.

COMETS.—See "Notes on Astronomy" in this number.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Nov. 25-Dec. 12	189	+ 73	Rather swift.
Dec. 4	162	+ 58	Swift, streaks.
,, 6	80	+ 23	Slow, bright.
,, 8	145	+ 7	Swift, streaks.
,, 8	208	+ 71	Rather swift.
,, 10-12	108	+ 33	Swift, short.
,, 12	110	+ 29	Rather swift.
,, 20-25	168	+ 33	Swift, streaks.
,, 22	104	+ 67	Swift, streaks.
,, 21-22	117	+ 47	Swift.
,, 31	92	+ 57	Slow, bright.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable (see Table 53).

TABLE 52. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reappearance. Time.	Reappearance. Angle from N. to E.
1914.			h. m.	°	h. m.	°
Dec. 1	17 Tauri	3·8	6 6 *e*	104	6 59 *e*	211
,, 1	16 Tauri	5·4	6 7 *e*	63	7 12 *e*	253
,, 1	19 Tauri	4·3	6 33 *e*	29	7 26 *e*	286
,, 1	20 Tauri	4·1	6 38 *e*	66	7 47 *e*	250
,, 1	22 Tauri	6·5	6 58 *e*	34	7 50 *e*	281
,, 1	21 Tauri	5·8	7 0 *e*	23	7 49 *e*	292
,, 1	BD + 24°·562	7·0	7 21 *e*	55	—	—
,, 1	BD + 23°·540	7·0	7 37 *e*	61	—	—
,, 1	Wash. 227	6·6	8 25 *e*	147	—	—
,, 4	BD + 27°·880	7·0	—	—	4 40 *e*	310
,, 4	BD + 27°·1122	7·0	—	—	7 49 *e*	316
,, 5	A Geminorum	5·1	7 8 *e*	43	7 43 *e*	325
,, 6	BAC 2506	6·3	2 38 *m*	80	3 51 *m*	312
,, 6	BAC 2514	6·0	3 16 *m*	101	4 31 *m*	301
,, 7	η Cancri	5·5	3 41 *m*	138	4 53 *m*	277
,, 8	Wash. 672	7·0	—	—	11 2 *e*	305
,, 18	Wash. 1283	7·4	4 29 *e*	52	—	—
,, 20	31 Capricorni	6·3	5 28 *e*	31	6 27 *e*	265
,, 21	ϵ^2 Aquarii	5·4	7 4 *e*	19	7 55 *e*	274
,, 25	51 Piscium	5·6	0 19 *m*	5	—	—
,, 29	16 Tauri	5·4	3 35 *m*	140	4 7 *m*	200
,, 29	19 Tauri	4·3	3 36 *m*	93	4 31 *m*	259
,, 29	21 Tauri	5·8	3 56 *m*	76	4 49 *m*	273
,, 29	20 Tauri	4·1	3 57 *m*	121	4 40 *m*	228
,, 29	22 Tauri	6·5	3 59 *m*	83	4 53 *m*	266
,, 29	BD + 24°·562	7·0	4 21 *m*	89	—	—
,, 31	Wash. 435	6·7	9 36 *e*	83	—	—

Attention is called to the two occultations of the Pleiades, in the East on December 1st, in the West on December 29th.

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

TABLE 53. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
R Tauri	4 24	+10 ·0	7·4 to 13·8	325	Oct. 31.
T Leporis	5 1	−22 ·0	7·5 to 12·3	366·5	Dec. 7.
S Camelop.	5 32	+68 ·8	7·8 to 10·8	330	Nov. 15.

Minima of Algol 2^d $9^h·9$ *c*, 5^d $6^h·7$ *c*, 8^d $3^h·5$ *e*, 17^d $6^h·0$ *m*, 20^d $2^h·8$ *m*, 22^d $11^h·6$ *c*, 25^d $8^h·4$ *c*, 28^d $5^h·3$ *c*. Period 2^d 20^h $48^m·9$.

Principal Minima of β Lyrae December 1^d 8^h *m*, 14^d 6^h *m*, 27^d 4^h *m*. Period 12^d 21^h $47^m·5$.

THE SELBORNE MAGAZINE.

FROM time to time *The Selborne Magazine* reflects the archaeological interests which occupied, with natural history, the attention of Gilbert White.

In a recent number there was a striking article, by Mr. W. Ruskin Butterfield, on "Sussex Draught Oxen," which are now reduced, we believe, to a single team. Their harness and shoes are therefore practically a thing of the past, and we are pleased to reproduce, by permission, some of the interesting photographs (see Figures 371 to 374) which Mr. Butterfield took to illustrate his remarks.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE TOTAL SOLAR ECLIPSE.—The observers have now returned, and it is possible to form an idea of the results obtained. The successful parties were those at Hernosand, Riga, Minsk, and a few in the Crimea. The British party in this last region was singularly unfortunate, being disappointed by a small cloud over the Sun in an otherwise clear sky.

I have seen some of the photographs taken at Minsk. The prominences were very numerous and active, several having fantastic forms suggesting a caterpillar, a galloping horse, and a clump of Jersey cabbages. The corona has been classified as of intermediate type; I should call it slightly modified minimum type. The polar plumes are still very pronounced, the equatorial streamers are wider than at dead minimum, but the large streamers at considerable inclination to the equator that were so prominent in 1898 are absent. It is curious that the coronal type of waxing activity is much less known than those of the other phases, so it is to be hoped that the eclipse of February, 1916, will be successfully observed.

MARS.—Professor W. H. Pickering gives, in *Popular Astronomy* for August, a final discussion of his observations of the recent apparition. He insists on the objective reality of the canals, and also on the fact that the aperture of the telescope used for their study cannot be advantageously extended beyond a certain point, depending on the steadiness of the air at the observing station. He gives a sketch of the Full Moon made with an opera-glass, showing many canaliform markings, and suggests that a study of these under higher optical power throws light on the Martian problem. He gives some diagrams of what the Martian canals might look like if we could see them under much higher optical power: these comprise single strips, double strips, and sets of dots very close together, forming a belt either straight or slightly sinuous; limits are given to the extent to which the real marking may diverge from straightness and uniformity without affecting the optical image that we see. He notes that "all the larger and more conspicuous canals are curved; the fainter ones, on the other hand, usually appear straight," thus suggesting that the straightness is an illusion. He suggests belts of vegetation, as the most plausible explanation of the canals; and, without laying stress on it, adds the conjecture that, if they are artificially controlled, the means employed might be the local deposition of moisture from the atmosphere by electrical or other means. He says these conjectures "account for the observed facts more readily than any others, and any theory, even a false one, is better than none at all"

ENCKE'S COMET.—This best known of all the short-period comets has been observed at Simeis, Crimea, this being its thirty-third observed apparition. Perihelion will be Dec. 4·9867, Berlin M.T., about half an hour earlier than that predicted by Herr L. Matkewitsch. In "KNOWLEDGE" for October, 1911, I predicted the date 1914, Dec. 5·0, which is almost exactly right. I can now extend the prediction to the following return, which comes out 1918, March 25·0. Winter returns are the most favourable for observation, and the comet is likely to be a conspicuous telescopic object in November.

Ephemeris for Berlin noon :—

Date.	R.A. h m s		Dec. ° ′
Nov. 6	13 23 49	......	21 58 N.
,, 10	13 45 48	......	12 43 N.
,, 14	14 2 13	......	5 20 N.

FIGURE [illegible].

Apparatus [illegible] the [illegible] of [illegible] and one [illegible]

Found in a [illegible]

FIGURE 372.

Ox-yoke in the Hastings Museum, from [illegible] Manor Farm.

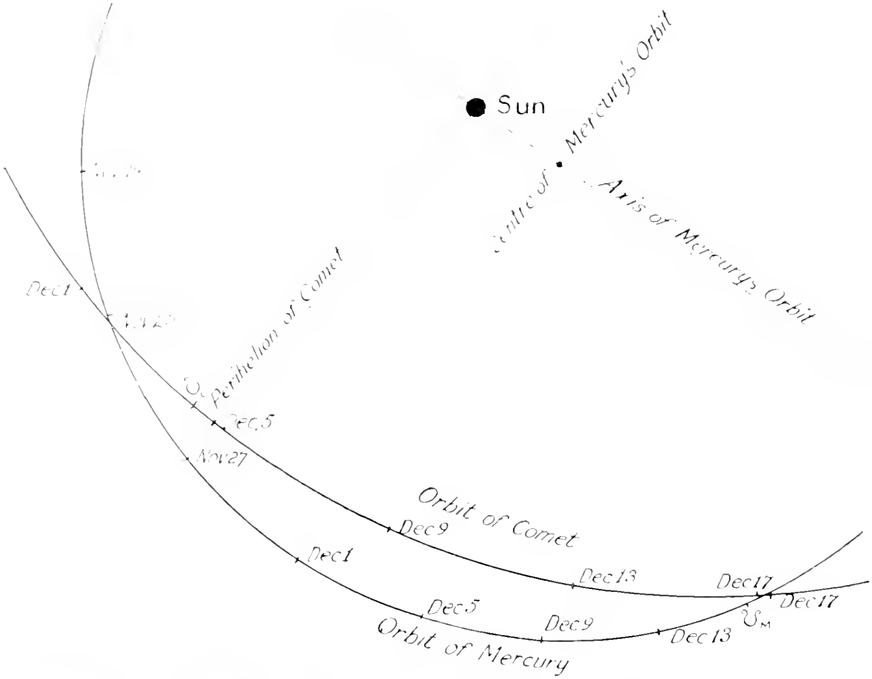
FIGURE [illegible].

[illegible] Shoes and Nails [illegible] to [illegible] them.

The upper pair [illegible] picked up on the [illegible] Beacon, the [illegible] was [illegible] shop at Brede, and the [illegible] are from Battle.

FIGURE [illegible].

[illegible]



[illegible] The perihelion portion of the Orbit of Encke's Comet, and the adjacent portion of Mercury's Orbit, illustrating the approach of the two bodies, 1914, December 10th.

[illegible] denote the descending nodes of Comet and Mercury on the plane of ecliptic. On December 10th Mercury is in plane of ecliptic, the Comet about nine million miles below it.

[illegible] Comet, Sept. [illegible] 1914.

[illegible] by [illegible] W. [illegible]

Date.	R.A. h	m	s		Dec. °	′
Nov. 18	14	15	40	......	0	15 S.
,, 22	14	28	20	......	5	50
,, 26	14	41	46	......	10	16
,, 30	14	57	33	......	14	20
Dec. 4	15	17	20	......	18	3
,, 8	15	41	12	......	21	18
,, 12	16	7	27	......	23	54
,, 16	16	34	6	......	25	50 S.

The comet will be within ten million miles of Mercury on December 16th (see Figure 375). It can at times approach even closer. These approaches have been utilised for obtaining the mass of Mercury, which is so small that its effect in disturbing even its neighbour, Venus, can scarcely be detected. But Encke's Comet can approach much more closely, and Professors von Asten and Backlund have studied the disturbances that Mercury produces on it, and find that the mass of Mercury is about one twenty-seventh of that of our own Earth. The effect of a near approach is not noticeable at once, as some imagine. All that Mercury has done is to alter the speed and direction of motion of the comet to a very slight extent. It is not till several years have elapsed that there is a sensible displacement of the comet from its predicted position. In the same way the effect of our Earth on Halley's Comet is scarcely noticeable at the time that it is near us, but it may make as much as two or three weeks' difference in the time of its return to perihelion seventy-five years later.

In 1848 the perihelion of Encke's Comet was on November 26th, nine days earlier than in the present year. The conditions as to visibility from the Earth were thus almost identical, and it is interesting to put on record the observations made then in order to ascertain how much loss of brilliance the comet has suffered in sixty-six years. It was discovered by Bond at Cambridge, U.S.A., on August 27th, 1848, as compared with September 20th this year (when its magnitude was given as 14·0). During September, 1848, and up to October 7th, it was described by Dr. Schmidt, of Bonn, as very faint and ill-defined, diameter nearly 8′, no nucleus or condensation, much harder to observe than most comets. On the other hand, on November 9th, he described the light of the comet as unusually intense, of the purest white; the condensation near the centre was very pronounced. It bore a magnifying power of two hundred or three hundred. The coma was 3′ or 4′ in diameter, but there was not much trace of a tail. I hope that our readers will observe it in the present month to admit of comparison.

Another bright comet was discovered on September 18th by Dr. Lunt, of the Cape Observatory. Many members of the British Astronomical Association who went to Vadso for the eclipse of 1896 will remember him. It was at first invisible in Europe, but has moved northward. By the time this appears the comet will probably be a telescopic object, but it is worth while to give the elements found by Mr. Wood and a portion of the ephemeris (for Greenwich midnight):—

T, August 4·99; ω, 270° 19′; ☊, 0° 22′; i, 77° 51′; log. q, 9·8543.

Date.	R.A. h	m	s		N. Dec. °	′
Nov. 6	21	47	21	......	5	42
,, 10	21	48	28	......	6	44
,, 14	21	50	4	......	7	38
,, 18	21	51	57	......	8	28

DELAVAN'S COMET.—There has been other activity in this field. Delavan's Comet, in its conspicuous position under the Plough, attracted general attention. An interesting photograph, taken by Mr. Longbottom (see Figure 376), showed that the tail consisted of a long, straight streamer, traceable for at least eight degrees, accompanied by a shorter, broader, slightly curved streamer, separated from it by a dark rift. It somewhat resembled the well-known pictures of Donati's Comet; but the straight streamer in Delavan's is relatively brighter, and the curvature of the broad streamer is less. The comet will still be observable as a morning star in November, but it will be very low down. The following is a rough ephemeris:—

Date.	R.A. h	m		Dec. °	′
Nov. 5	14	47	......	19	4 N.
,, 15	15	16	......	13	24
,, 25	15	39	......	7	0
Dec. 5	15	58	......	1	0 N.
,, 15	16	11	......	4	0 S.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

SYMBIOSIS BETWEEN FRESHWATER MOLLUSCS AND ALGAE.—Several cases of symbiosis, or mutual partnership, between algae and animals (protozoa, sponges, and so on) have been already recorded. One of the most remarkable is that between certain marine red algae and sponges, discovered by Mme. van Bosse in her work on tropical algae; in some cases the alga branches profusely and ramifies through the canal system of the sponge, the alga using for food the carbon dioxide given off by the living sponge tissues, obtaining its salts from the water passing through the canals, and, on the other hand, supplying the sponge with the oxygen given off in photosynthesis. More recently Iltis (*Biol. Centralbl.*, Volume XXXIII, No. 12) has described a form of the common freshwater red alga, *Batrachospermum* (*B. vagans* var. *epiplanorbis*), which always grows on the shell of the freshwater mollusc, *Planorbis*. The mollusc gains by being protected from enemies, being densely clad with the alga, and is also able to live in places which would be otherwise unfit for it owing to poverty of oxygen and excess of carbon dioxide, the former gas being supplied, and the latter removed, by the alga. Further, the *Batrachospermum* lives in symbiosis with the blue-green alga *Nostoc*, colonies of which are lodged among its branches. The author describes some other similar cases of symbiosis between freshwater snails of the genus *Limnea* and a number of green algae belonging to the genera *Vaucheria*, *Cladophora*, *Chaetophora*, and *Oedogonium*. It would appear that this simple type of symbiosis is fairly common among pond organisms.

TRANSPIRATION AND OSMOTIC PRESSURE IN MANGROVE TREES.—The well-known mangrove vegetation of tropical shores, forming one of the most sharply defined of all plant communities, consists of trees showing marked "xerophilous" characters—thick, leathery leaves with sunken stomata, and so on—which have been usually attributed to "physiological drought." According to this view, flowering plants growing in saltwater live under practically the same conditions as plants growing in physically dry soil, since the salinity makes it difficult for them to obtain a sufficient supply of water, and from the structure of their leaves it has been generally assumed that they lose very little water by transpiration. However, various recent observers have found by experiment that many supposed "xerophytes" lose water from their leaves at a fairly rapid rate. Faber (*Ber. deutsch. bot. Ges.*, Volume XXXI) has found that this is the case with the mangrove trees, which are rooted in mud covered by seawater, and he also finds that the osmotic pressure in the cells of these plants is extremely high—very much higher than that observed in plants growing in ordinary soil. This high concentration of the sap is especially marked in the leaves, and experiments showed that the mangrove plants have a remarkable capacity for the regulation of their osmotic pressure in such a way that their sap always remains more concentrated than the water by which the roots are surrounded. It has already been proved that the fleshy desert and salt-marsh plants, previously regarded as typical "xerophytes," that is, plants which economise their water supply and lose very little in the form of water vapour from their leaves, are,

when tested by actual experiment instead of by pure inference from structural features, found to show a relatively large rate of water loss (transpiration), often quite as large as that of "mesophytes" (thin-leaved plants growing where the water supply is ample and there are no obvious features for checking water loss). These observations show the danger of inferring too much about the physiology and ecology of plants from details of form and structure alone.

TRANSPIRATION IN CACTI.—Various recent observers have shown that many plants with fleshy leaves or stems, which were formerly regarded as typical "xerophytes," from general and superficial observation of their habitat and habit, or in some cases from the anatomical structure of their aërial organs, and which were supposed to lose water very slowly by virtue of their water-storing tissues and their "adaptations" for checking water loss, prove on actual experiment to lose water quite as rapidly as "mesophytic" plants devoid of such arrangements for water economy. In one of the latest papers on this subject Bedelian (*Bull. Jard. imp. bot.*, St. Petersburg [Petrograd], 1913) gives the results of transpiration experiments made with the cactus, *Opuntia tomentosa*, a number of other plants being also used for comparison. The amounts of water, in grammes, lost from equal areas of green surface (flat stem in *Opuntia*, leaves in the other plants) in an hour were as follows: Ivy, 0·0082; oleander, 0·0057; *Tropaeolum*, 0·0066; sunflower, 0·1059; *Opuntia*, 0·0063. It is remarkable that a thin-leaved plant like *Tropaeolum* should transpire at practically the same rate as the cactus and the oleander: the last-named plant has its stomata protected by being grouped in cavities of the leaf, opening by a hole, which is guarded by hairs. Some of the unexpected results of this kind obtained by experiment may be explained by the very different behaviour of the stomata in different plants, as well as in the same plant under different conditions. However, it is, at any rate, obvious that "xerophyte" and "xerophilous" are at present very vague and much-abused terms, and that ecological conceptions and terms must be based on accurate experimental work in plant physiology; also that much remains to be done on the transpiration of plants and the various factors, internal and external, by which it is controlled.

PARASITISM IN THE YELLOW-RATTLE TRIBE.—The yellow-rattle tribe (Rhinantheae) of the family Scrophulariaceae has been closely investigated from the biological point of view by Heinricher, who has published various papers on these interesting plants. As is well known, *Rhinanthus* (yellow-rattle) and its allies, *Pedicularis* (red-rattle, lousewort), *Melampyrum* (cow-wheat), *Bartsia*, and so on, are partial parasites, drawing water and salts from various grasses and other plants, to whose roots theirs are attached by suckers, while they have green leaves, and can therefore carry on photosynthesis. However, it seems that, under the general description "semi-parasitism," there is comprised in this tribe a number of distinct, but closely connected, stages between slight parasitism and almost complete dependence upon the host plant for both organic and inorganic food materials. In a recent paper Heinricher (*Ber. nat.-med. Ver. Innsbruck*, Volume XXXIV) summarises his observations on this tribe, and describes the interesting series of forms which at one end join on to the normal Scrophulariaceae, obtaining their food materials in the usual way from the salts in the soil and the carbon dioxide of the air, and at the other end lead to the totally parasitic Orobanchaceae, including toothwort (*Lathraea*) and broomrape (*Orobanche*), and regarded as having arisen by reduction from the Scrophulariaceae. The series begins with the eyebrights (*Euphrasia*), which apparently take only water and salts from the host plant, and in which normal carbon assimilation is performed by the leaves. These, and other true green parasites, show an extremely rapid rate of transpiration, correlated with their method of taking up nutritive salts at second hand. In the rattles (*Rhinanthus*, *Pedicularis*) a certain amount of organic food is absorbed by the roots, and the leaves show a reduction of the assimilating tissues: this is still more pronounced in cow-wheat (*Melampyrum*) and *Bartsia*. In *Tozzia alpina* there is a more marked approach to absolute parasitism, the plant living for a year or two years as a semi-parasite, and for several years as an absolute parasite. These various stages are marked by corresponding differences in structural details of leaf, stem, root, seed, and so on.

CHEMISTRY.

By C. Ainsworth Mitchell, B.A. (Oxon), F.I.C.

ACETIC ACID FROM ACETYLENE.—Two recent French patents of the German firm, Bayer & Co., claim methods of manufacturing acetic acid from acetylene. According to the first of these, a current of the acetylene is passed through a solution containing hydrogen peroxide, persulphuric acid, or one of its salts, in the presence of mercury, or one of its compounds. For example, the gas is made to traverse a mixture of dilute sulphuric acid and ammonium persulphate solution, in which is suspended 5 to 10 parts of mercuric oxide. The temperature is meanwhile maintained at 30° to 40° C., and the liquid will finally contain from twenty-four to twenty-five per cent. of acetic acid, which may be separated and concentrated by distillation.

In the other process an electrolytic cell with a clay diaphragm and a lead anode is charged with dilute sulphuric acid containing one to two per cent. of mercuric oxide, and the acetylene is passed through the liquid previously heated to about 30° C. A regulated electric current effects the oxidation of the acetylene, and about a pound of acetic acid per quart of the solution is obtained.

In view of the scarcity of acetic acid for pickling purposes, owing to the stoppage of the supplies from Belgium, Germany, and Sweden, these processes could probably be profitably worked in this country.

TWO NEW MODIFICATIONS OF PHOSPHORUS.—The element phosphorus is remarkable for the large number of allotropic modifications which it yields under different conditions of temperature. The red amorphous variety and the scarlet modification are the best known of these forms, and both of these are of commercial importance in the match industry. Several other modifications are known, and in the last issue of the *Journ. Amer. Chem. Soc.* (1914, XXXVI, 1344) Mr. P. Bridgman gives an account of two more. The first of these, which he terms "White Phosphorus II," is a hexagonal crystalline form obtained by cooling ordinary white phosphorus to about −76° C. at the ordinary atmospheric pressure. The other modification is a black variety, which is formed when white phosphorus is heated to about 200° C. under high pressure. It does not ignite spontaneously, and acts as a good conductor of heat and electricity, while it melts at a somewhat higher temperature than red phosphorus. Its density is 2·691, and its vapour pressure is lower than that of red phosphorus.

COAL TAR PITCH AND CANCER.—In a pamphlet published last year by Doctors Ross and Cropper, and reviewed at the time in "Knowledge," a scientific explanation was suggested of the facts that workmen handling gasworks tar are subject to epitheliomatous cancer, whereas those engaged in the distillation of the pitch from blast furnaces are not affected in this way.

Starting from the hypothesis that two of the factors inducing cancer are (1) rapidly proliferating cells on a chronically injured surface and (2) abnormal migration of those cells into the neighbouring tissue, attempts were made to isolate from the tars specific substances producing these results.

The method employed was to subject white blood-cells

to the action of various compounds for ten minutes at 37° C. Those substances which caused cell proliferation by division were termed *auxetics*, while those producing amoeboid movements in the cells, when acting in the presence of auxetics, were described as *kinetics*. About thirty-one compounds (including creatinine, xanthine, methylamine, and leucine), which acted as auxetics, were discovered, while the kinetics included cadaverine, choline, and atropine.

Moreover, it was found that, whereas gasworks tar and pitch contained both auxetics and kinetics, blast-furnace pitch contained only a small amount of auxetics and no kinetics.

Further experiments upon the isolation and separation of the active substances in gasworks coal tar have recently been published by Mr. D. Norris (*Biochem. Journal*, 1914, VIII, 253), who has found that the auxetics are bases present in the anthracene fraction of the tar. They may be separated by shaking the tar with dilute hydrochloric acid, and treating the acid extract with ammonia, which precipitates them. They combine with picric acid to form insoluble picrates, one of which melts at 199° C., and has the composition $C_{22}H_{11}O_3N_6$.

On exposing an aqueous extract of the tar to the air its auxetic activity rapidly disappeared, and the tar could also be rendered inert by heating it to 160° C. and subjecting it to a current of air or ozonised air. This simple method of removing the dangerous constituents from the tar has been patented by Dr. Ross (Eng. Pat. 11,984 of 1913).

Another method claimed to destroy the auxetic activity of the pitch is to treat it with formaldehyde. This has been made the subject of two English patents by Mr. Robinson, and is being tried on a large scale at briquette works in Cardiff.

GEOGRAPHY.

By A. SCOTT, M.A., B.Sc.

GEOGRAPHY OF THE WAR AREA.—In an article, entitled "Some Rough War Notes" (*Geog. Jour.*, October, 1914), Professor Lyde gives an interesting summary of the geographical conditions of the parts of Europe contained in the present war area. The critical area in the western theatre is the "north-east quadrant of the Paris basin." Here there is the same succession of Mesozoic and Tertiary sediments as in the south-east of England, save that the dips trend westwards, and the steep escarpments face the east. Many of those towns, now familiar, in name at least, to everyone as the scene of conflicts, command gaps in the chalk or limestone. Further east the ground is more difficult, but even the hill forest of Argonne is no longer such an obstacle to armies as it was during the French Revolution, as much of it has now been cleared and drained. The valleys of the Upper Meuse and Moselle, with their tortuous courses and liability to floods, and the broken wooded nature of the country present greater obstacles. Professor Lyde discusses briefly the natural barriers of this region, and comes to the conclusion that the Rhine is the only good frontier, although it is not a good military or political barrier.

The internal divisions of the German Confederation are also considered, and the suggestion made that the unity is one "of economic interest rather than of political kinship." Apart from the peoples west of the Rhine, there are, from an ethnic point of view, several other "loose" units. The inhabitants of the Weser basin are closely related to the Danes, not only physically, but also with respect to religion, being strongly Protestant. The Vistula basin, again, is occupied by Poles (save in East Prussia, where the people are essentially Prussian), who are mainly Roman Catholic.

The conditions in the interior of Germany, and on the Austrian border, are more complicated. From Posen, on the Oder, to the Upper San valley the country is an alternation of marshes and reclaimed lands of great fertility. The foodstuffs produced by this area and the oil of the Galician wells become exceedingly important under modern conditions of warfare, while, in addition, there is an abundance of transport facilities, with Przemysl as the natural centre of the system. Bohemia, though comparatively isolated by natural boundaries, is, nevertheless, an excellent supply base owing to its fertile soil and mineral wealth. This is more obvious when the manufacturing districts of South Germany are considered. Here there is such a dependence for foodstuffs on external supplies that the whole region must capitulate as soon as its access to the outer world, chiefly by the Rhine, is cut off. These parts, the Schwarzwald, the Rauhe Alps, the Hessian Woodlands, are occupied by the best of the Teutonic types; but, despite their industrial organisation and scientific agriculture, the sandy plains are not sufficiently fertile to feed their population, while the richer areas of the lower Rhineland are given up to vine and tobacco cultivation. The only other access to foreign markets is through the region of the Middle Danube. This route, however, is much less important, as the areas surrounding the Hungarian Lowlands are occupied by a heterogeneous mass of people, who not only differ widely among themselves in political and economic interests, but are also fiercely antagonistic on religious grounds—one group belonging to the Greek Church and another to the Roman Catholic Church. The dominant class, however, is composed of the Magyars, who are Protestant, and who, though of Asiatic origin, have assimilated so much that is good from their environment that they now form the best type in the region.

The author has appended a list of the published maps of the regions involved in the war.

ILL-FATED ARCTIC EXPEDITIONS.—Definite information has now been obtained of the extent of the disaster to the Stefansson Arctic Expedition. The "Karluk" was believed to be frozen in for the winter near the mouth of the Colville River, in Alaska, when a gale partly broke up the ice on September 20th of last year, and caused the boat to drift in a westerly direction. The drifting continued until January 11th, when the ship was struck by an ice-sheet and so seriously damaged that it sank, about eighty miles north-east of Wrangell Island. A map in the July *Bulletin* of the American Geographical Society indicates the direction of this eight-hundred-mile drift, first in a general north-west direction and then south-west. Captain Bartlett made his way to Wrangell Island, and thence across Long Sound to Siberia, finally reaching St. Michael, in Alaska. The United States revenue cutter "Bear" rescued eight members of the expedition on Wrangell Island. Of the remainder three, including Mr. Mallock (geologist) and Mr. Maken (topographer), died on the island. Four, including M. Beuchat (anthropologist), Dr. Mackay and Mr. Murray (biologists), did not reach the island. While they may possibly be on Herald Island, which neither the "Bear" nor another vessel which made the attempt, could touch owing to bad weather, it is probable that they did not survive the ice journey. The only surviving scientific man is Mr. McKinlay (meteorologist).

Sedoff's Expedition, which left Russia in August, 1912, for Franz Josef Land, has also met with disaster, as the leader, Captain Sedoff, died of an illness north of Franz Josef Land in March, 1914. Sedoff's vessel has rescued the survivors of the Brussiloff Expedition, which left Petrograd in the summer of 1912. Eleven members left the boat at Franz Josef Land, and nine of these died at various places between there and Cape Flora, where the two survivors were picked up by Sedoff's party. Nothing further has been heard of the remainder of the expedition; but, as the boat is well provisioned, there is considerable hope that they will have survived.

GEOLOGY.

By G. W. TYRRELL, A.R.C.S., F.G.S.

THE SATURATION OF MINERALS.—In the February number of "KNOWLEDGE" (Vol. XXXVII, page 69), a

paper, by Professor Shand, on "Saturated and Unsaturated Igneous Rocks" was commented upon in this column. The view was put forward that the saturated or unsaturated state of the constituent minerals with regard to silica was a natural basis for igneous rock classification. The criterion of saturation was the capability of co-existence of the mineral with free silica, as determined by the observed facts of distribution.

Mr. A. Scott questions the validity of this criterion in a paper on "The Saturation of Minerals" in *The Geological Magazine* for July. His main point is that "so many factors, external and internal, influence the cooling of a rock that in many cases the resultant solid is not in a condition of maximum stability." Consequently, rocks which have had different "cooling histories" are not comparable in respect to saturation. Many minerals only form within a certain range of pressure and temperature, being stable for these conditions and unstable for others. Yet the vicissitudes attending crystallisation may be such that the mineral survives under a subsequent unfavourable set of conditions, and may then be associated with other minerals in respect to which it is unsaturated. Moreover, minerals such as the garnets, topaz, and so on, which require special conditions for their formation, cannot be said to be "saturated" or "unsaturated" in the sense that albite, nepheline, or leucite can be. Igneous rocks have such different cooling-histories that a natural or genetic classification cannot be based on the final mineralogical composition, or on such a factor as saturation with respect to silica, employed in the empirical fashion suggested by Professor Shand.

GRAVITATIVE DIFFERENTIATION.—In his most original and suggestive work on "Igneous Rocks and their Origin," Professor R. A. Daly, of Harvard, presents a useful conception of the process of differentiation whereby homogeneous magmas are broken up into two or more unlike parts. Differentiation may be conceived as consisting of two stages: a *physico-chemical* stage, in which the units of differentiation are prepared, and a *geological* stage, in which these units are segregated and arranged in their respective positions within the igneous mass. The units may be solid crystals, or liquid globules, or even liquid crystals, and they may be separated from the magma by means of crystallisation, or by the process known as liquation, by which the magma splits up into partially immiscible portions. The units thus formed may be concentrated at various places within the igneous mass, according to the conditions under which the process takes place. If the separation of the units occurs just before the consolidation of the magma, they may be frozen in place without any appreciable segregation. When the units are crystals this would give rise to a uniform undifferentiated mass of igneous rock. When, however, immiscible liquid fractions have been produced by liquation, the resulting magma constitutes an emulsion. A good example of an igneous emulsion is the rock known as quartz—or granophyric — dolerite, in which a doleritic fraction, consisting of lime-soda felspar, augite, and iron-ore, is well mixed with, yet quite distinct from, a granophyric fraction, consisting of quartz and alkali-felspar. When the units of differentiation are produced in a thinly liquid magma some time before its consolidation, the heavier units must tend to sink under the influence of gravity, thus becoming separated from the lighter units, and concentrated towards the lower levels of the igneous mass. The whole process may be illustrated in a homely way by the contents of some medicine bottles. When left standing, the liquid frequently separates into two or more layers, the heaviest of which collects at the bottom. An emulsion may be reconstituted by shaking the bottle. A similar sorting process may be demonstrated in many igneous masses. In Mull, for example, the officers of the Geological Survey have found three cases of gabbro masses which merge in an upward direction into granophyre. Here the quartz-dolerite emulsion mentioned above has clearly been left standing, and has separated into its unlike fractions, the heavier of which has collected towards the base of the mass. Many other examples of gravitative differentiation have been described, and have been interpreted by Daly and others on the lines indicated above.

A FURTHER DISCOVERY AT PILTDOWN.—According to a note in *Nature* of September 3rd, further excavations at Piltdown have yielded to Mr. C. Dawson and Dr. A. S. Woodward a second portion of a molar tooth of *Mastodon*, larger and more characteristic than the fragment formerly described. The new specimen agrees well with the teeth of *Mastodon arvernensis* from the Red Crag of Suffolk. As it is waterworn, it is clearly a derived fossil of earlier date than the Piltdown gravel in which it is found.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

CLOUD-BURST IN MALTA, OCTOBER 16TH, 1913.—Dr. Thomas Agius, the Director of the Meteorological Observatory at Valetta, has communicated to the *Bolettino Mensuale* of the Italian Meteorological Society an account of the remarkable cloud-burst which occurred in Malta on October 16th, 1913. At Valetta the total rainfall for the day was twelve and a half inches, of which, according to the self-recording gauge, six inches fell between 1 and 3 p.m. The greatest amount for the day measured in the island was 16·30 inches at Vittoriosa, the next highest rainfalls being 15·26 inches at Cospiqua, and 13·03 inches at Zabbar. The least amount measured in the island was 2·36 inches at Melleha. In the adjoining island of Gozo the rainfall on the day in question varied from 2·04 inches at Kala to 0·44 inch at Garbo.

THUNDERSTORMS IN THE SUDAN.—In "KNOWLEDGE" for November, 1913, reference was made to some particulars about thunderstorms in Egypt, which Mr. E. W. Bliss had given in the *Cairo Scientific Journal*. He has since collected similar data for the Sudan. The few thunderstorms which occur in Egypt generally come in spring and autumn; in the Sudan, on the contrary, thunderstorms are very frequent during the months of July to October. During the last five years, 1909–13, the total number of days on which thunder or lightning was reported was as follows:—

Wadi Halfa	2	El Obeid	173
Merowe	42	Gallabat	62
Atbara	10	Roseires	42
Kassala	211	Wau	20
Khartoum	167		

As regards the diurnal variation, the maximum number of thunderstorms occurs at all stations between 6 and 10 p.m. This is also the time of the maximum number in Egypt.

TESTING ANEROIDS FOR USE ON AËROPLANES.—In the Report of the National Physical Laboratory some interesting particulars are given respecting the testing of aneroids and barographs. A special test was made on an aneroid for use on an aëroplane. This instrument was necessarily very light. It was the only one of its kind tested during the year, and it was found to behave satisfactorily. For decreasing pressure, the errors were found to be within ± fifty feet at all points tested. Two barographs have been tested at the Laboratory. They were both sent by the Royal Aëro Club, and showed records of the pressure registered during flights in aëroplanes. The examination of these instruments is rather interesting, and so the procedure may be worth mentioning. The instrument is received at the Laboratory in exactly the same state as it was found on the aëroplane after the completion of the flight, except that the pointer had been lifted from the paper. The clockwork is set going, and the instrument placed in the receiver of the aneroid testing apparatus, in which the pressure is adjusted so that the pointer falls on the beginning of the trace. As the drum revolves the pointer is made, by suitable variation of the

pressure, to follow closely over the trace made during the flight. At intervals along the trace the corresponding true pressures are read on the standard-gauge barometer. In this way a very accurate estimate of the true pressure corresponding to the maximum point on the trace can be made. To arrive at the actual height reached above ground level, it is necessary to know the following data: (1) The place of ascent and its height above mean sea level; (2) the date and hour of ascent; and (3) the difference between the pressure at ground level and that at the maximum height. The particulars given under (1) and (2) are referred to the Meteorological Office, to ascertain as closely as possible from their records the atmospheric conditions at the time and place of flight. Item (3) is got direct from the calibration of the barograph at the Laboratory. The information necessary for calculating the maximum height attained is then complete. The degree of accuracy to which the height can be certified depends partly upon the closeness of the barograph scale and the thickness of the trace and partly on the amount of information available as to the atmospheric conditions at the time of flight. For the two instruments tested the results were given to ± two hundred feet.

BRITISH RAINFALL, 1913.—The fifty-third annual volume of *British Rainfall*, which has been published at an earlier date than in any year since 1902, contains records of rainfall from five thousand three hundred and seventy stations, an increase of ninety-eight over the previous year. The greatest amounts of rainfall in 1913 were 183·25-in. at Loch Quoich, Inverness-shire; 167·00-in. at Crib Goch, Snowdon; and 165·44-in. at The Stye, Cumberland; and the least amounts of rainfall were: 16·67-in. at Crowle, Lincolnshire; 16·96-in. at Cambridge; and 17·07-in. at Guthram, Bourne, Lincolnshire.

An exceptional fall of rain occurred in the neighbourhood of Doncaster during a thunderstorm on September 17th, when 6·43 in. fell in 14 hours.

For the British Isles as a whole the general rainfall was almost exactly equal to the average, as the extensive moderately wet areas in the west and the extremely dry east coast strip counterbalanced one another.

In one of the special articles Mr. R. C. Mossman gives the results of a fresh discussion which he has made on the occurrence of heavy rains in short periods by including falls up to two hours. The total number of cases dealt with was one thousand four hundred and forty-one, spread over the forty-six years 1868–1913. Taking the country as a whole, the maximum frequency is in July, during which month one third of the total number of cases occurred. This is equally true of all the other districts of the British Isles, except Scotland, where the maximum falls in August. The July maximum is most marked in Ireland, where forty-six per cent. of the cases took place in that month. In the north-east and north-west of England the values are also high, reaching forty-one per cent.; but in the south-east the frequency considerably diminishes to thirty-three per cent., while in the south-west of England the number in July has fallen to under twenty-eight per cent., and in Scotland to 24·5 per cent. The variations in frequency of heavy rains are doubtless closely related to variations in the frequency of thunderstorms in the different divisions of the country.

MICROSCOPY.

By F. R. M. S.

III.—THE COMMON EARWIG (*Forficula auricularia*).—(*Continued from page* 374.)—Another characteristic distinction between the sexes can be seen in the illustrations (see Figures 377 and 379) which have been produced under the same magnification. The ♀ insect appears shorter in length than the ♂, but in body, width, and segments it is larger, and, as mentioned before, the latter number seven in the ♀.

The ♂ in its shape appears thinner than the ♀, and the segments, numbering nine, are narrower in width.

In all other general features of appearance the two sexes are practically similar: the head, antennae, wings, and legs can be treated together, the following description applying to both sexes.

The head of the insect is large in proportion to the body, and works on a distinct neck, which gives great freedom of motion; the former carries powerful mandibles and maxillae (biting jaws), strongly curved, ending in sharp teeth-like projections (see Figure 378).

The mandibles are simple in structure, and work in a condyle, this in turn working in a small cup to the various regions of the head.

The first maxillae, or second pair of jaws, are next to the mandibles, or first pair of jaws, and have a two-jointed basal part, which include the five-jointed palps, used for feeding and feeling, the two terminal parts of the latter being termed galea and lacinia, seen side by side. These palps are shown as organs with three joints in the illustration, one on each side of the head; the other parts are hidden behind the antennae bases.

The second maxillae, or third pair of jaws, known also as the labium, hang as a flap, and serve to close the mouth from behind, whilst its shield-like base is divided into a lower part (mentum) and an upper part (submentum). The three jointed palps are fixed to the sides of the mentum and parts answering to the galea and lacinia, as found in the first pair of maxillae, can be made out.

The labium really consists of a pair of appendages exactly similar to the maxillae, but the latter are fused together in the middle line.

We must remember that the jaws of insects and spiders, and so on, are really modified legs, differing in their origin and action from the jaws of vertebrate animals, working from side to side like a pair of scissors, and not up and down or backwards and forwards.*

The large compound eyes are present below the labial palps and antennae, bulging out prominently on each side of the head. It is remarkable and interesting to find that simple eyes, or ocelli, as found in many other insects, especially in the Muscidae (*e.g.*, House Fly), are entirely absent.

The antennae of both sexes, ♂ and ♀, are made up of large segments, which vary somewhat in size. The first segments at the base are very short; the succeeding segments become longer and continue about the same size towards the tips. These antennae are very long, and in both ♂ and ♀ appear to be the same in structure, presenting no points of difference as found in many other forms of insect life.

Each segment shows a conical formation, the base being much narrower than the apex; short, stiff hairs are sparsely scattered on their surface, and at the nodes these hairs become lengthened. In the illustrations (see Figures 380 and 382) it appears as if each segment were hollow, for a distinct thickening is visible on the outer walls, and connection from one segment to another is plain in that of the ♀ (see Figure 380).

The wings of the Earwig form a most interesting feature, and are seldom seen save during exceptional circumstances: they are of large size, semicircular in shape, and in texture are extremely delicate and filmy.

Under the very small elytra, or wing-cases, each wing is carefully packed away, held in place on the upper part of the thorax.

A small part of the wing is regularly exposed: the tip of the anterior margin projects more or less beyond the elytra, but the membranous portions are entirely concealed.

The delicate membrane of the wing is crossed by radiating lines, or veins, which commence from a horny plate occupying about a third of the anterior margin (see Figure 381).

* *Injurious and Useful Insects*, Miall, pages 14–15.

A little away from the origin of these veins the spaces between are cut up by a series of shorter veins, which run to the edge of the wing, and all the veins are united by a delicate vein which runs parallel to the outer edge. The extreme base of the wing is made up of several irregular cell-shaped spaces.

By means of the radiating veins, or lines, the apical and posterior parts of the wing can be folded like a fan, which is then doubled up under the horny margin of the base. The fan portion is capable of a transverse fold near the basal ends of the secondary veins; at various points these secondary veins and others are curved somewhat and slightly thickened

In folding or unfolding the wings the Earwig uses its flexible abdomen by bending the latter forward over the back, and thus great assistance is given to the performance. Enock, in his wonderful account of these wings, shows how the marvellous process of unfolding and folding for and after flight is carried out in every stage.*

Owing to their nocturnal habits, Earwigs are seldom seen to fly, and the wings seem to be used with great reluctance during the day when the insect is disturbed.

Many Earwigs have been found adhering to newly tarred boards during night time, and in each case their wings were fully expanded. This suggests a ready way of capturing them.

The legs of both ♂ and ♀ are exactly the same size, and present the same general features when closely examined. The fore legs are small in comparison with the hind legs, whilst the middle legs form a medium between the two extremes (see Figure 383). The Earwig relies on its legs for escape, and they are particularly adapted for rapid locomotion, as can easily be demonstrated when the insect is disturbed in its retreat.

Each pair of legs is attached to a segment of the thorax, and each leg is divided up into five distinct parts, as found in all the insect family.

We have first the coxa (Latin, hip), or basal joint, which appears to be rounded on its broad sides; thus each leg increases in length as we pass from the first to the third leg. Adjoining the coxa is the trochanter (Greek, =a runner), a small piece connecting the coxa with the femur, or thigh, the latter being considerably elongated, and at its base covered with long, stout hairs (see Figure 384).

The tibia, or shank, the fourth joint in the leg, is also elongated, but much shorter in length than the femur. On its inner edge it is thickly covered with a heavy fringe of stout hairs, which appear to be equal in length.

The tarsus, or foot, is composed of two parts, the first being very short and circular in shape on its inner edge, while at the base are two small protuberances, sparsely covered with a few short, stout hairs.

It is interesting to note that in its near relative, the Cockroach, the tarsus of the latter is made up of five distinct portions, diminishing in size towards the claws, whilst the Earwig has the last portion of the tarsus considerably lengthened, and nearly equal to the tibia The small protuberances present are no doubt aborted segments of the tarsus, and the long fifth segment is an abnormal development of this portion.

This fifth segment, or ungula, terminates in two sharp-pointed claws, which are worked independently of one another by means of powerful muscles.

W. HAROLD S. CHEAVIN, F.R.M.S., F.E.S.

PHOTOGRAPHY.

By EDGAR SENIOR.

SILVERING MIRRORS FOR PHOTOGRAPHIC PURPOSES.—While many formulae have from time to time been published for silvering mirrors, the technical difficulties attending the production of a silvered surface having such qualities as permanence and adherence are, as a rule, very considerable. Experience has shown that, although it is fairly easy to obtain a perfectly satisfactory silvered surface on blown glass, considerable difficulties are encountered when dealing with surfaces of polished glass, more particularly when the coated side is required to act as the reflecting surface, as in this case the high polish necessary to be given to the silver coating is difficult to produce on account of the soft nature of the deposit, and it is scarcely possible to obtain it without showing scratches. On this account it is found desirable to use a process of silvering that gives a highly reflecting surface without requiring to be polished. Methods of silvering in which formic aldehyde are employed, while they give very even reflecting surfaces, are, at the same time, somewhat unreliable. In Eder's *Jahrbuch* for 1913 a method of silvering glass is published which, according to the experience of Dr. Miethe, yields mirrors in which the silver deposit is both lasting and highly adherent, while, at the same time, it has the maximum reflecting power. It is also stated that great purity of the chemicals employed is not essential, and that such excessive care in obtaining a chemically clean glass surface is not required.

For the preparation of the silver solution the following formula is recommended:—

No. 1.

Silver nitrate	30 grammes (463 grains)
Water (distilled).........	900 c.c. (31·5 ounces)

No. 2.

Caustic potash	20 grammes (309 grains)
Water (distilled).........	900 c.c. (31·5 ounces)

The above solutions having been prepared, seven hundred and fifty cubic centimetres (26·25 ounces) of No. 1 are put into a bottle and ammonia added, drop by drop, until the precipitate first formed is just redissolved, when the whole of No. 2 is slowly added with constant shaking between each addition, in order to avoid the formation of a coarse precipitate. The resulting mixture has a deep brown opalescent appearance, and must be constantly shaken, while a further addition of ammonia is made, drop by drop, until a bright, clear solution is obtained, care being taken to avoid any excess of ammonia. The remaining one hundred and fifty cubic centimetres (five and a quarter ounces) of No. 1 is then added, when the liquid again assumes a brownish opalescent appearance; it is then filtered and kept ready for use in silvering. After an hour or two a small quantity of a black precipitate begins to deposit, but this does not affect the silvering, providing the solution is either filtered or the clear portion drawn off for use; and it is found that old solution works just as well as fresh. A certain amount of care should be exercised in keeping and handling the solution, as it has been found on occasion to explode with sufficient violence to break the bottle into small pieces. As a reducing agent we can employ either grape sugar or inverted cane sugar, the latter being prepared as follows:—

Lump sugar	25 grammes (385¾ grains)
Tartaric acid	3 ,, (46 ,,
Water	250 c.c. (8¾ ounces)

The solution is brought to the boiling-point, and kept at this for from ten to fifteen minutes, when it is cooled, and fifty cubic centimetres (one and three-quarter ounces) of alcohol added, when the whole is diluted to five hundred cubic centimetres (seventeen and a half ounces) by the addition of water. If preferred, a five-per-cent. solution of grape sugar may be employed as a reducing agent. The quantity of the reducing agent used in comparison with the silver solution has an effect upon the result; thus, if ten parts of silver solution to one part of reducing agent be employed, the silvering takes place quickly, but the silver is not clean and bright, and the deposit adheres badly, while, if the proportion of the reducing agent is about thirty per cent. of that of the silver solution, the most

* *Marvels of the Universe*, Vol. II, pages 1104–1108

permanent and brightest coating is obtained. If the proportion of the reducing agent is still further increased, the silvering proceeds very slowly, and although the coating has not such a fine surface it is extremely even by transmitted light, and affords a very suitable means for the preparation of filters for the transmission of ultra-violet radiations. The method given above, however, is the one best suited to the silvering of glass required to be used as a reflector.

MANIPULATIONS IN SILVERING.—The glass to be silvered is laid at the bottom of a dish (preferably a glass one), with the surface to be coated uppermost, the silvering solution being allowed to cover it to a depth of at least eight or ten millimetres (one-third to two-fifths of an inch). During the process of silvering the dish should be rocked continuously, and the solution, which quickly assumes a golden-yellow colour, begins to deposit silver after about twenty or thirty seconds. The surface of the glass becomes coated with a deposit, which at first is of a bluish colour; this quickly changes to a silver grey, and, finally, a metallic surface is seen to form. The dish being constantly rocked, the silvering process is allowed to proceed until the silver is seen to deposit in small particles, which gradually increase in size, and which would finally, if the action were allowed to proceed too far, cover the entire surface with a grey coating closely resembling leather. However, before this stage is reached the operation must be stopped at a point which has to be learnt by experience. Silvering for too short a time produces a deposit which is easily damaged, while, if the operation is continued for too long a time, the surface is dirty and of a poor reflecting nature. When the silvering operation is finished, the solution is poured off, and the surface washed with distilled water, after which a large tuft of cotton-wool, wetted with distilled water, is carefully passed over the silvered surface with a light, but gradually increasing, pressure. It will be found, after a few minutes, that the water is repelled by the silvered surface, when the remaining water is removed by the use of a sheet of filter paper gently applied by the hand. After drying off the last trace of water, a perfectly uniform and brilliant reflecting surface should be obtained. The mirror will then be ready for use without further treatment. If, however, a slight film of a bluish tint still remains, it may be removed by passing across the surface a pad of cotton-wool, covered with a piece of chamois leather freed from grease. If this is applied with a light pressure, the silver coating becomes perfect, and of the maximum reflecting power. Mirrors prepared according to the method above-described are found to remain perfect for a length of time if kept in a pure atmosphere; they are, of course, quickly affected by sulphuretted hydrogen, but they may be protected for months against the injurious influence of this gas if they are wrapped in paper which has been impregnated with acetate of lead, or they may be stored in a box, the lid of which has been covered with paper of this nature. When, in course of time, the mirror becomes tarnished, the only remedy appears to be to resilver it, as it is difficult to remove the tarnish without impairing the surface. Any attempt to clean the surface by means of a solution of potassium cyanide has the disadvantage of dissolving the silver deposit in parts. It has been stated that mirrors prepared by the process described retain their properties for a longer time than those that are prepared by most other processes, and that the method has further advantages over those generally used.

PHYSICS.

By J. H. Vincent, M.A., D.Sc., A.R.C.Sc.

POWERFUL ELECTROMAGNETS.—The most powerful electromagnets available up to quite recent times were of the Ruhmkorff pattern, and served very well for the demonstration and study of diamagnetism and magneto-optical rotation. In 1896 Zeeman, using a Ruhmkorff electromagnet, discovered the effect which bears his name. The magnetic field attainable in this apparatus over a sufficient space to permit of Zeeman's experiments on the magnetic resolution of spectrum lines was about twenty thousand gauss (or twenty thousand lines of induction, per square centimetre). In 1894 Du Bois had published his design for an improved magnet of a circular shape, which gave a much stronger field, and this apparatus soon began to replace the older type; but it was itself largely superseded by the semicircular pattern of Du Bois, which has been still further improved. With these improved electromagnets a field of forty-five thousand gauss may be readily obtained through a limited space. When magnetic fields much stronger than this are desired the expense of construction and power consumed become excessive. Perrin suggested in 1907 the use of liquid air for cooling the magnet coils, but the suggestion, so far as I know, has never been carried out. In 1909 Weiss designed a magnet with solenoids of copper tape in paraffin oil cooled by water coils, which gave a field of forty-six thousand gauss. Weiss has also employed water-cooled copper tubes as conductors. About 1909 Du Bois, by increasing the number of ampère turns on his semicircular magnets, obtained a field of nearly fifty thousand gauss; by employing extra coils close to the air gap even this field could be exceeded. The more nearly the iron of the magnet is saturated, the greater the benefit from these coils. Experiments by Ollivier in 1910 showed that by using long straight cores without a yoke it is possible to obtain fields as high as forty-five thousand gauss. In 1911 Du Bois still further improved the design of his magnets, chiefly in the direction of providing greater facilities for their employment in different kinds of magnetic research. Weiss found in 1913 that a distinct improvement results from the employment of ferro-cobalt (Fe_2Co) for the tips of the pole pieces instead of Swedish iron. In January of the present year Deslandres and Pérot published descriptions of electromagnets in which the coils near the air gap in the Weiss and Du Bois magnets are given greater importance. The extra coils were kept cool by the circulation of chilled petroleum, and carried very intense currents (one thousand one hundred ampères). The resulting field was fifty-one thousand five hundred gauss. In March these authors announced that, by increasing the dimensions of their apparatus, they hoped to get a field of one hundred thousand gauss. In the *Comptes Rendus* for August 24th they advocate reliance on intense currents, and deprecate the use of large masses of iron. By the temporary employment of the resources of an electric-supply station in Paris they were able to get a field of fifty thousand gauss without the use of iron. The solenoids were made of silver tape, and were cooled by immersion in running water. These experiments have raised their ambition, and they now think that a field of one hundred and fifty thousand gauss is to be obtained by these methods, but the work has been stopped by the war.

PRODUCTION OF SOFT RÖNTGEN RADIATION.—Two methods of producing very soft x-rays, i.e., x-rays of long wave-length, are described by Sir J. J. Thomson in a paper in *The Philosophical Magazine* for October. There is a gap of about eight octaves between the softest characteristic x-radiation yet investigated and the shortest known waves of ultra-violet light. These very short light-waves are about 9×10^{-6} centimetres long, while the longest x-rays have a wave-length of $3{\cdot}6 \times 10^{-7}$ centimetres. By the study of waves intermediate in length Sir J. J. Thomson hopes to find out the details of the arrangement of the constituent electric charges of the atoms. The first method given in the paper is not only a means of getting x-rays of a previously unknown type, but is also a new method of obtaining x-rays. Hitherto the only way has been to generate them by the impact of cathode rays. It now transpires that positive rays will also yield x-rays when they strike a solid. These x-rays are of a very soft kind, that is, they are not penetrative, and have presumably a relatively

great wave-length. The apparatus used in the first method allows the positive rays to pass out of the part of the vacuum tube, where they are formed, through a long perforation in the cathode. After passing between a pair of insulated metal plates the positively charged particles strike a platinum target. The soft x-rays, which have their origin at the point of impact of the positive rays on the target, traverse a side tube sealed on to the main vacuum tube; and, after passing between a similar pair of electrodes to that between which the positive rays passed, strike a specially prepared photographic plate. This plate is in the vacuum tube, and is placed at right angles to the length of the side tube. Each pair of insulated plates is provided with means by which a strong electric field can be set up in the space between the plates. The photographic plate is partially screened by a metal plate, with a slit in it to give definiteness to the image. By noting the effect of putting on the electric field in the space between the electrodes, it is shown that the resulting photographic effect is really due to x-rays, and not to any other type of radiation. This new x-radiation has a very small penetrative power. The thinnest films of collodion, mica, paraffin wax, and white fluorite are opaque to it: it differs from harder x-radiation in being capable of ordinary reflection.

In the second part of the paper a method of making x-rays of a graduated scale of softness is described. Cathode rays in great quantity are obtained from a white-hot baryta-covered platinum cathode These pass through a hole in the anode, and strike a target of copper, which is in electrical connection with a layer of gauze, through which the cathode rays pass on their way to the copper target. Variation in the speed of the cathode rays hitting the target is produced by the cathode particles being repelled by the gauze after passing through the anode; to effect this the gauze is given any desired voltage below that of the anode. If v_1 is the voltage driving the cathode ray tube, and v_2 that between the anode and gauze, the speed of the rays striking the target is proportional to $v_1 - v_2$. A side tube and photographic plate are used as in the first apparatus; the effects produced on the plate are shown to be due to very soft x-rays. By altering the speed of the cathode rays from the slowest, which will excite any detectable radiation up to that due to a few hundred volts, x-radiations gradually changing in penetrative power are excited. With very low speeds the resulting rays are unable to pass through the thinnest films of collodion, and other solids; but as the speed of the cathode rays increases, so does the penetrative power of the x-rays to which they give birth.

RADIO-ACTIVITY.

By ALEXANDER FLECK, B.Sc.

COLLOIDAL SOLUTIONS OF THE RADIO-ELEMENTS.—The first step in our knowledge of the existence of these solutions was taken by Paneth (*Kolloid-Zeitschrift*, Vol. XIII, page 1), when he was experimenting on a mixture of the members of the radium slow-change active deposit. Radium-D, -E, and -F were dissolved in a neutral solution, contained in a vessel of parchment-paper or of animal membrane, and it was found that, when this vessel was surrounded by pure water, the radium-D and -E could pass through its walls, but that there was no radium-F (polonium) in the external liquid. The particles of polonium had not been able to penetrate the membrane. He therefore came to the conclusion that this experiment was analogous to the dialysis of a mixture in solution of colloidal silica and hydrochloric acid. The acid can pass through because it is crystalloidal, but the silica cannot because of its colloidal nature. In neutral solution, therefore, radium-F is present as a colloid. The same worker then attempted, in collaboration with von Hevesy, to determine the number of simple radium-F atoms that were joined together to form a colloidal particle. It is well known that in ordinary colloids the aggregation of molecules making a colloidal particle is very great. The method adopted depended on the fact that in excess of the acid ion the velocity of diffusion of the metal ion was inversely proportional to the electric charge on that ion. In this way it was found that these colloidal molecules of the radio-elements contained at the most eight simple atoms. These results have received independent support from the experiments of Godlewski, working with entirely different methods. This work was based on the results obtained by electrolysing a pure-water solution containing radium emanation. He found that under these conditions a large fraction of the activity due to the active deposit was obtained on the anode, while in an acid solution the activity is found on the cathode electrode. He therefore concluded that radium-A (known to be analogous to polonium) was not present in the ordinary ionic condition, but as a colloid.

HYDROGEN α-PARTICLES.—It has long been recognised that the α-particles emitted by uranium, radium, and other radio-active bodies consist of atoms of helium, of atomic weight 4, carrying two unit charges of positive electricity. One property of these α-particles is that, when one strikes a zinc sulphide screen, a flash of light is produced which can be seen with the aid of a microscope. When emitted, they have a speed of approximately 2×10^9 centimetres per second. When this speed falls below a certain critical velocity the atom ceases to be an α-particle, and becomes an ordinary helium atom. When α-rays go through a quantity of hydrogen (unit atomic weight) the speed acquired by hydrogen atoms that have been in collision with them must be very great, and it seems reasonable to expect, from considerations stated by Bohr (*Philosophical Magazine*, Vol. XXV, page 10), that the "range" of such hydrogen particles should be four times the "range" of the α-particle producing them. These have been called "H" particles, and their existence has been shown by Marsden in a recent number of the *Philosophical Magazine* (May, 1914). The apparatus initially employed was very simple, and consisted of a glass tube, of about one metre long, closed at one end by a zinc sulphide screen, viewed with a microscope. A strong source of α-rays was fixed to a small iron stand, which could be moved along the tube by a hand magnet operated externally. When the apparatus was closed and filled with hydrogen it was found that scintillations could be observed on the zinc sulphide screen long after all the original α-rays had been absorbed by the hydrogen in the tube. Additional experiments were made which showed that these scintillations could be produced by hydrogen alone, and that they were therefore due to "H" particles.

THE ORIGIN OF THE γ-RAYS.—These very penetrating rays have for many years been recognised as due to vibrations produced somewhere within the atom. They are thus quite distinct from the α- and β-rays, which are both produced by the expulsion of a small part of the atom itself. Rutherford has put forward the suggestion that the γ-rays are caused by the passage of a β- or α-particle through a ring of electrons situated in the interior of the atom. The electrons in this ring are quite distinct from those governing valency and ionic phenomena. As is well known, β- and γ-rays are closely associated, whereas, on the above assumption, one would expect a much greater disturbance, and therefore the production of more γ-rays, to accompany the emission of an α-particle. Russell has shown that γ-rays are produced in these circumstances, but these rays are of exceedingly small importance. To explain an analogous case, namely, the absence of γ-rays in connection with the intense β-rays of radium-E, Rutherford (*Philosophical Magazine*, September, 1914) makes the assumption that the β-rays are always emitted in some direction fixed relative to the intra-atomic structure, and that the γ-rays can only be set up in certain limited regions. γ-rays, on this assumption, only accompany the β-rays when these

latter "pass through or near a region where characteristic (γ) radiations can be set up."

This is another reason for leading us to believe that the nucleus of the atom has a complex structure just as the atom itself is complex.

ZOOLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

HOW A MOULTING LOBSTER WITHDRAWS THE MUSCLES FROM ITS CLAWS.—In their interesting and beautifully illustrated book on "The Animal Life by the Sea-shore" (1914), Drs. G. A. and C. L. Boulenger make an instructive note on the way in which the lobster (or any similar Crustacean) gets the muscles of the big claw through the narrow basal segment. Just before the moulting "the water and blood which swell the muscular part are withdrawn, and cause the tissues to shrivel up to such an extent as to allow of its being forced through a narrow opening." After the moulting the muscle soon becomes turgid again, the proportions are restored, and the claw is bigger than ever. The authors give a diagrammatic sketch, showing how the fleshy part shrivels before the moult.

REMARKABLE EPIZOIC OLIGOCHAETE.—A peculiar little worm, with a surprising mode of life, was found by Major Kelsall in Sierra Leone, and is described by H. A. Baylis. It lives attached to the outside of a large (unidentified) Earthworm, and belongs itself to the Earthworm (Oligochaete) stock. The posterior half of the body is flattened and expanded into an oval disc, bearing numerous transverse rows of ventral bristles. The total length was five millimetres, and the specimens were sexually mature. As the food canal contained earth and vegetable débris, it seems probable that the small worm uses the large worm simply as a means of transport. Mr. Baylis proposes the name *Aspidodrilus kelsalli* for this interesting new animal.

DEEP-WATER SNAILS OF THE LAKE OF GENEVA.—In the shore area of the Lake of Geneva there are four species of *Limnaea*, viz., *L. stagnalis*, *L. palustris*, *L. auricularia*, and *L. ovata*. They are mainly vegetarian, and they breathe air at the surface of the water. In the depths of the lake, down to one hundred metres, there are two species, *L. profunda* and *L. abyssicola*. They are mainly carnivorous, and they breathe cutaneously. Compared with those of the shallow-water area, the deep-water forms have rather smaller eyes, though not in any way degenerate, and they seem to be less prolific. Now, by making a very careful comparison of specific characters, and taking due account of varieties, W. Roszkowski has convinced himself that the deep-water forms are not worthy of being regarded as distinct species, but are abyssal varieties of two of the littoral species. In short, *L. profunda* is a variety of *L. ovata*, and *L. abyssicola* of *L. palustris*; and it is not likely that the varieties were established until after the Glacial period.

EVOLUTION OF MAMMALIAN HAIR.—Mammals probably evolved from an ancient Reptilian stock, but from what did hairs evolve? Many answers have been offered, but none seems satisfactory. Hairs have been hypothetically derived from scales, from parts of scales, from touch-spots of Reptiles, from integumentary sense-organs in Amphibians, from pearl-organs in Fishes, and so on. All the views have been recently reconsidered by E. Botezat, who comes to the conclusion that hairs are *sui generis*, and that they were evolved by mammals without any affiliation to other structures in other vertebrates. He thinks it likely that the primary function was sensory, and the secondary function protective. In any case, there have been two main lines of hair-evolution in mammals, the one ending in the non-sensory, woolly hair, specialised for protection, the other ending in the mobile, tactile hair, or vibrissa, specialised as a sensory structure.

PATERNAL CARE.—Everyone knows that there are not a few examples of marked parental care on the part of male animals. Sea-spiders or Pycnogonids, Sea horses, and Nurse-toads occur to one as good illustrations, and it is noteworthy that the cases are scattered here and there in the animal kingdom. The phenomena have been insufficiently studied. One would like to know whether some of the cases have evolved from a state of affairs in which the parental care was thoroughly bi-parental, as in some birds. One would like to know whether the instinct of caring for the eggs and offspring has been in some cases grafted on to the male sex, just as it sometimes appears as if certain masculine characters could be grafted on to the female sex. Witness the Red-necked Phalarope. One would like to know whether there is in any case some connection between the parental care and the sexual impulse. The subject demands further study. How quaint, for instance, is the case of the water-bug Zaitha, where the female, as Professor Abbott describes it, "seizes the weaker male, and, in spite of his struggles, glues her eggs all over his back, transforming him, for the time being into a nurse."

SIDE GLANDS OF SHREWS.—It is well known that while cats will kill shrews, they never eat them. This is believed to be due to the repulsiveness of a secretion produced by a line of skin glands on each side of the shrew's body. It has a strong and characteristic scent, especially during the breeding season. Sigurd Johnsen has shown that the glandular lines consist of exaggerated sweat-glands, accompanied by sebaceous glands, which may also be exaggerated. The odoriferous secretion is due mainly, if not exclusively, to the activity of the sweat-glands, and this activity waxes and wanes with the reproductive activity. While the sebaceous glands go on increasing during the shrew's short life of a couple of years or so, the sudorific glands of the lateral organ attain their maximum at sexual maturity. It seems likely that the glands have come to be connected with sex, and that the odoriferous secretion helps the animals—solitary and nocturnal—to find one another. This is not inconsistent with the view that the odour may also be protective. Johnsen found the lateral organs developed in *Sorex araneus*, *S. minutus*, *Neomys fodiens*, *Crocidura russula*, and *C. leucodon*.

MALAYAN PANGOLIN.—W. Schultze contributes some interesting notes on a specimen of *Manis javanica*, which he kept in captivity for three weeks. It fed on arboreal termites, which make large hard nests on the trees. The pangolin first removes the outer brittle layer from one side, and then hollows out the very hard interior, breaking it away piecemeal by inserting its claws into the passages or cells, and using them as levers. When it reaches the termites it keeps its tongue busy. It often hollows out the nest so that the general shape is left. The nests are from twenty to fifty centimetres in diameter, and the captive pangolin emptied four of medium size in one night.

The pangolin seems to have poor eyesight, at least during the day. It seems to depend on scent. When liberated tentatively, it always made for the nearest forest or thicket. It never turned towards open places or the sea. If disturbed when walking about, it quickly put its head between its fore legs, turned a somersault, and rolled itself up into a ball, making a hissing noise. Its tail, which has a horny pad at the end, is useful in climbing and in hanging on to the branches. The animal has a very peculiar odour.

A STRANGE HOME.—The contrast between free-living animals (Eleutherozoa) and fixed plants is vividly illustrated in Professor E. F. Gautier's description of a hill near Jelfa, in Algiers, which is composed entirely of rock salt. It reaches a height of over three hundred feet, and has a diameter of under a mile. Neither on the salt hill itself, nor on the salt-impregnated clays on its margins is there any plant life, except in a few sink-holes, which are choked with alluvial deposits. In great contrast to this is the abundance

of animal life, especially of birds and bats. The salt "mountain" is quite a bird-berg—for hawks as well as doves—which feed at a distance, but shelter and breed on the rock.

EMERODS, MICE, AND THE PLAGUE.—Professor D. Fraser Harris has a note on the view that the plague of I Samuel vi, 5 was bubonic plague, the word "emerod," or "haemorrhoid," referring in all likelihood to the buboes, tumours, or swellings in the region of the groin or elsewhere. The plague, or "Black Death," is now known to be due to a bacillus, discovered by Yersin and Kitasato in 1894, which also occurs in mice, rats, and marmots. Man is usually infected by being bitten by a flea which has been feeding on a plague-stricken rat or other rodent. The interest of the five golden mice which were made on the recommendation of the Philistine soothsayers is considerable, for it is possible that there was some glimpse of the truth that the overrunning of the land with mice was not unconnected with the plague of emerods. Professor Fraser Harris notes that "No rats, no plague," is an old saying amongst the people of India.

FRILLED SHARK OFF THE COAST OF BRITTANY.—Among the gristly fishes, the most archaic living type is the Frilled Shark (*Chlamydoselachus anguineus*), first described from Japan, but afterwards captured off Madeira, off the Azores, and off the coast of Spain, Portugal, and Norway. It is a rare deep-water fish, and its occurrence near La Rochelle is of great interest. It is reported on by Drs. J. Pellegrin and E. Loppé, who note its length as about five feet. The body is elongated; the mouth is nearly terminal; there are six gill-clefts; there is a hint of a gill-cover; in the posterior part of the trunk the notochord is unconstricted; the lateral line is an open groove. The characters of the Frilled Shark are well known, but almost nothing is known of its habits. It is the only representative of its family, Chlamydoselachidae.

HABITS OF HYRAX.—In a report on mammals from the Blue Nile Valley, Mr. Glover M. Allan has something to say about the habits of Butler's Hyrax (*Procavia butleri*). The animals live in dens among huge boulders, and often sit motionless at the entrance. When convinced of safety, they delight to bask in the sun in the early forenoon. They may also be seen running for a long distance from rock to rock, and then diving into a hole. Their enemies are leopards and other carnivores or predaceous birds; and in this connection it is rather surprising that they have a way of occasionally throwing aside all caution, and bounding a few paces from their holes of a sudden. "Perched on a boulder, they look about, or give a characteristic sharp bark of two syllables at short intervals for some minutes at a time." In fact, they show a rather curious combination of shyness and boldness.

NEW FAMILY OF AMERICAN GOATSUCKERS.—Harry C. Oberholser finds that the American Goatsuckers of the genus *Chordeiles*, and several related genera, must be separated from the Caprimulgidae and placed in a new family, Chordeilidae. The cranial characters are very distinctive. The detailed study is very interesting, for the genus *Chordeiles* includes only three specific types (with races), namely *virginianus*, *acutipennis*, and *rupestris*, which are trenchantly different, and are evidently genera in process of evolution. As to habits, the members of the genus *Chordeiles* are birds of the open country, strong-winged, insectivorous, and very beneficial. They spend much of their time in the air, and their great gapes are well suited for insect-catching. Their feet are weak, and not well adapted for perching. The birds usually crouch on the ground, on fence-rails, low branches, and the like. On a fence-rail they almost invariably sit lengthwise. They build no nest, but deposit their two well-mottled eggs on the ground or similar places. The young are practically helpless for some time after birth.

BRIGHT COLOURS OF MALE BIRDS.—One admires the courage, at any rate, displayed by Dr. J. C. Mottram in maintaining that the male bird "becomes brilliant in colour, in order that he may be more likely to be destroyed, and thus the dull-coloured female gain protection." We believe it to be true that some male birds try to distract attention from the nest; and we believe, as Darwin did, that variations may be established which are for the advantage, not of the individual, but of the race. But we cannot believe in Dr. Mottram's theory. Leaving aside the faulty teleological expression "becomes brilliant in colour in order that," we cannot get over the difficulty that the more effective the males were in being killed, the more the conspicuousness would tend to be eradicated from the race. But the author of the theory ingeniously suggests that the pairing would occur before death, so that the male would hand on the valuable quality of conspicuousness through the unaffected female line to his male descendants. "The conspicuous colour of the male serves to control natural selection in such a way that the less valuable male will be killed in preference to the more valuable female." This appears to us to be arguing in a circle, since we do not know of any absolute biological value. A character has only value in relation to the particular exigencies of the species, that is, in relation to the particular selection that goes on. It cannot, therefore, control selection.

OX WARBLE-FLIES.—The full-grown larvae of the Ox Warble-fly (*Hypoderma bovis*) leave the cattle and pupate in the ground. The flies emerge between the middle of June and the beginning of September. They have a very short life of, on an average, between four and five days. They do not eat at all. They fly quickly, but only in fine weather, and never far. A German observer, Gläser, saw a female lay five hundred and thirty-eight eggs on a cow in three-quarters of an hour, each on a single hair. A French observer, Lucet, found about three hundred and fifty ova in the abdomen of each of four flies. While Gläser attributes panic among cattle to the Warble-flies, Lucet placed the flies on and beside a calf, and observed no trace of fear or annoyance. Lucet found that an injection of iodine into the nodosities containing the Warbles killed the larvae without fail, and that subsequent absorption occurred without any suppuration—a fact of much practical importance. Professor G. H. Carpenter and Mr. Thomas R. Hewitt describe what Gläser has also seen, the newly hatched larva of *Hypoderma bovis*, a stage which has hitherto been missed. It is a tiny maggot with formidable mouth-hooks and with strong, spiny armature in seven or eight irregularly arranged rows of spines around most of the segments.

Gläser placed newly hatched larvae on the shaved skin of a calf, and observed that they made no attempt to bore through. This might be used as an argument by those who insist that the egg or larva must be swallowed by the cow or calf. But Carpenter and Hewitt found that muzzled calves, apparently unable to swallow either the eggs or young, were at the most but partially protected from infection. The strong mouth-hooks and piercer and the well-developed, spiny armature of the newly hatched maggot suggest that it could, perhaps, bore as readily through the skin as through the mucous coat of the gullet.

Moreover, Gläser had a curious experience. A maggot, hatched from an egg laid on his trousers by *Hypoderma lineatum*, bored through the skin of his leg and disappeared in an hour and three-quarters. Four or five days later the larva could be felt through the skin. This was in June. It apparently worked its way upwards, for early in September swellings were apparent on the hip and abdomen, and at the end of that month a swelling in the lower end of the gullet was indicated by pain when swallowing. On October 2nd Gläser had a two-fold satisfaction in extracting a Warble-maggot from his own mouth.

FIGURE 377. The Earwig (*Forficula auricularia*). [illegible]

FIGURE 378. Head of the [illegible] showing mouth [illegible] appendages [illegible]

FIGURE 379. [illegible] Earwig.

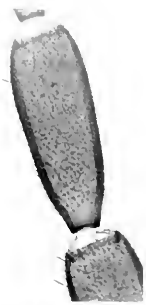


FIGURE 380. Antenna Segment of the ♀ Earwig. × about 80.

FIGURE 381. Left W[illegible] the Earwig [illegible] horizontal and vertical [illegible] basal p[illegible]

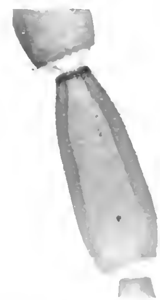


FIGURE 382. Antenna Segment of the ♂ Earwig. × about 80.

FIGURE 383. The Legs of the Earwig. × about 10.

[illegible] of the Earwig [illegible]

Figure 385.

An Ancient Egyptian Bow-drill. Rapid movement is produced with one hand, while the other is free to manipulate the drill. (*After Rosellini.*)

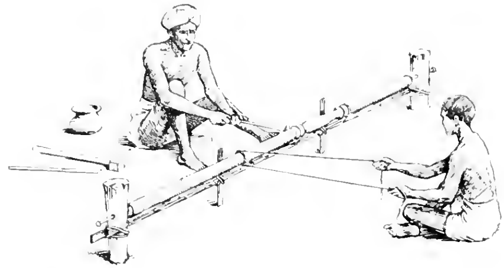


Figure 388.

An Indian Lathe with two workers. (*After Holtzapffel.*)

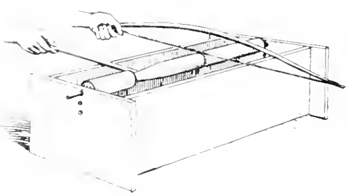


Figure 386.

A Persian Bow-lathe. The piece of work takes the place of the spindle in the bow drill and is horizontal. (*After Holtzapffel.*)

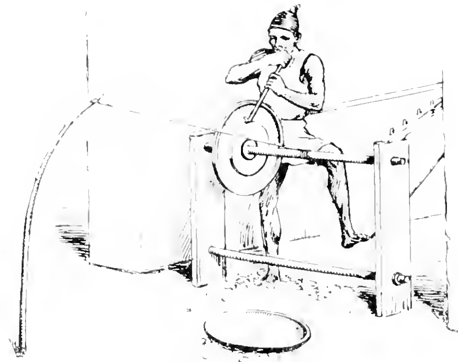


Figure 389.

A Kabyle Pole-lathe. (*After Knight.*)

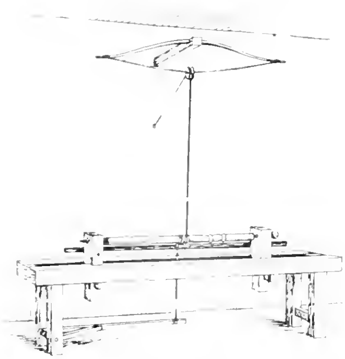


Figure 387.

An Archery Bow-lathe with treadle (seventeenth century). (*After Diderot and D'Allembert.*)

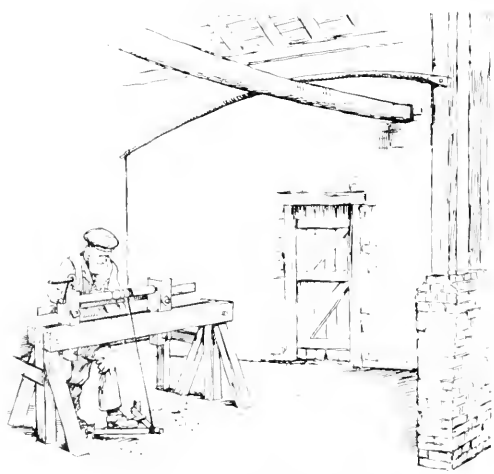


Figure 390. An English Pole-lathe.

THE POLE-LATHE.

By WILFRED MARK WEBB, F.L.S.

(*Continued from page 361.*)

In making an endeavour to follow out the development of the pole-lathe it will be well to consider what other simple methods are, or have been, adopted to make objects revolve backwards and forwards as a means to an end.

Nothing could well be more primitive than boring with a pointed flake of flint, or, for that matter, with a modern brad-awl, held in the hand and twisted first one way and then the other. The action is of necessity somewhat slow, but greater speed can be obtained by rubbing a stick between the palms of the hands, as is done by native races in the making of fire with the fire-drill. In this case it is not easy to put much pressure upon the instrument that revolves. A very ingenious device, which removes the drawback by leaving the hand free to hold down the drill, was invented in very early times. It consists in making a loop in a bow-string, and putting it round the drill, which is kept in place by the operator with one hand, while the other, by moving the bow backwards and forwards, causes the tool to revolve in alternate directions. Such a bow-drill was in use in ancient Egypt, and one is shown in Figure 385, which is taken from a monument. The head of the drill is pivoted on to the spindle, so that rapid movement can be produced.

To convert the bow-drill into a lathe is a very easy matter: all that is required is to turn it from the vertical into a horizontal position, and to pivot it at two fixed points. The Persian bow-lathe (see Figure 386) is about as simple as one could possibly be. The idea may have arisen through a desire to work upon the spindle of a drill which was temporarily placed in a horizontal position for the purpose. On the other hand, it is possible in the case of the lathe, where the material to be turned has no string round it, but is fixed to a mandrel, that the suggestion of making it revolve may have been given by a drill becoming fixed in an object while it was being bored, and this, as a consequence, being twisted backwards and forwards by the movements of the bow.

In the Persian lathe one hand is, of course, free to hold the tool, but to have both at liberty for this purpose would be better. In the Indian lathe (see Figure 388), by removing the bow altogether and putting a boy to pull the ends of the string alternately, the turner can take both hands to the tool.

It may be mentioned that the bow-lathe still survives, and is used in this country by jewellers when turning very fine work.

Another method of freeing the second hand is by bringing a foot into play. In the Kabyle lathe the string is only detached from one end of the bow, which is fixed firmly in the ground (see Figure 389). After passing round the spindle of the lathe, the string is fastened to a support at a little height from the ground, and, by pressing his foot on the line, the turner works his lathe. It will be noted that the latter is used for turning bowls or trays, and that, as in the English pole-lathe used for this purpose, the string does not pass round the actual work.

It is not a very big step from such an arrangement as the Kabyle lathe to one with a proper treadle. Figure 387 shows an archery bow-lathe, and Figure 390 an English pole-lathe, turnished with treadles. By this time it will have become clear that the pole of the pole-lathe is only an exaggerated bow fixed at one end, and the cord or strap fastened to the other—merely a thickened bow-string.

REVIEWS.

ASTRONOMY.

The Elements of Descriptive Astronomy.—By E. O. Tancock, B.A. 110 pages. 15 plates. 21 figures. 7½-in. × 5-in.

(Oxford: The Clarendon Press. Price 2/6 net.)

The author in his preface says: "I have endeavoured in this book to give a simple description of the heavenly bodies and their motions in a form which should appeal to those who know little or nothing of the subject." We think he has achieved his object with marked success.

The book consists of fifteen chapters and a supplementary one of questions, fifteen plates of typical objects in the heavens, twenty-one good illustrations in the text, and is concluded with an index of those subjects given in clarendon type.

In reading the book we noticed a few errors or omissions, and we give two of them, so that they may be corrected in a future edition, of which we hope to see many. On page 51 the magnetic needle should be only 15° west, not nearly 20°; and in Chapter VI there is an inexplicable omission of any reference or statement to the fact that Saturn has satellites.

It is not easy to sum up Astronomy in about one hundred small pages, and be of practical use; but we think the author has given his descriptions of the elements of general Astronomy in simple, clear, and concise words; the examples

are apt. He has written a really useful book, and one well adapted for teachers—who are themselves sufficiently acquainted with Astronomy—of children from about twelve years old.

The paper and printing leave nothing to be desired, and if the price could be made sixpence or one shilling lower the book should be in the hands of, or recommended by, all educational bodies.

F. A. B.

Publications of the Solar Physics Committee.—12-in. × 9¾-in. each memoir.

(Wyman & Sons.)

The work of the South Kensington Observatory is brought to a close by the issue of these three memoirs entitled :—

(I) "On the Spectra of the Rigelian, Crucian, and Alnitamian Stars; (II) The Line Spectrum of α Orionis; (III) The Spectrum of γ Cassiopeiae" (one volume).
41 pages. 3 plates. Price 3/6.

"Areas of Calcium Flocculi on Spectro-heliograms, 1906–08."

7 pages. 1 plate. Price 9d.

"On Some of the Phenomena of New Stars."
63 pages. 4 plates. 2 figures. Price 5/-.

All three volumes have been produced under the direction of Sir Norman Lockyer. The first by Mr. Baxandall consists of three papers, which form a continuation of memoirs dealing with the classification of stars based on their chemistry, as exhibited in their spectra. The classification is here carried further by the subdivision of the Alnitamian class. The next paper in this volume contains a detailed comparison of the line spectrum of α Orionis with that of Arcturus and the Sun, while the third gives a table of the wave-lengths, probable origins, and general description of the dark lines in the spectrum of γ Cassiopeiae.

The report on Calcium Flocculi, prepared by Mr. Butler, consists of tables and curves. The tables give the areas of the calcium flocculi in millionths of the Sun's projected hemisphere, while the curves show these areas, together with the areas occupied simultaneously by sun-spots.

In the paper on New Stars, Sir Norman Lockyer continues a communiciaton to the *Philosophical Transactions* of 1890, while the general conclusions to be derived from the whole work are deferred to a further memoir. It is impossible in a short note to do justice to the value and interest of this important research. We must content ourselves with briefly indicating some of the matters dealt with. It is shown that there probably exists a normal course of development of the light of a new star as shown in the spectrum. The spectrum rapidly passes through well-defined states, while the light rises to a maximum intensity and fades away again. The lines in the spectra are found in other celestial sources, and most of them have been tracked to their origin in known chemical elements. The distribution of new stars in space is very remarkable: they all seem to be very distant, and (with one notable exception) lie in those parts of the sky occupied by the Milky Way, its branches, or the Magellanic Clouds.

J. H. V.

BIOLOGY.

The Philosophy of Biology.—By JAMES JONSTONE, D.Sc. 391 pages. 9-in. × 5¾-in.

(The Cambridge University Press. Price 9/- net.)

This book, intended for the lay as well as the scientific public, will repay the most careful study, even though we may not see eye to eye with the author in all his conclusions. He is evidently one of an increasing number of scientific men who cannot reconcile some of the most important phenomena exhibited by organic beings with any mechanico-chemical law, and have come to the conclusion that to continue effort in this direction is but to plough the sand. Nevertheless, he recognises the value of work on this hypothesis, and rejects the theory of "vital force" as affording any intelligible explanation of the facts. The constructive part of his work seems to us far more satisfactorily accomplished than anything we have read lately. The appendix especially demands close attention, if the reader is to follow the doctrine of *entropy* and its application to the living organism. In any case it is a difficult idea to grasp. The accurate and comprehensive knowledge of the author, his clear thinking and mode of expression, render the book a most valuable addition to the literature of the subject, and it is indispensable to every biologist who is, or would like to be, something of a philosopher as well.

M. D. H.

Researches into Induced Cell-Reproduction in Amoebae.—By JOHN WESTRAY CROPPER, M.B., M.Sc., and AUBREY HOWARD DREW. Volume IV of the "John Howard McFadden Researches." 112 pages. 10 plates. 33 figures. 9-in. × 5¾-in.

(John Murray. Price 5/- net.)

It may be said at once that this book is one of extreme interest and importance to biologists. Experiments have shown that normal cell-reproduction and benign tumours are caused by certain chemical agents called "auxetics," such a tyrosin and creatin, and that cancerous tumours are caused by mixtures of auxetics with another group of substances called "kinetics" or "augmentors," such as choline and cadaverine.

The authors in this fourth volume of the "John Howard McFadden Researches" have not dealt with body cells, but with amoebae. The type employed is one for which the name *Amoeba ostrea* has been suggested; it was found growing in a sodium citrate and sodium chloride solution, which had been lying exposed to the air in the laboratory. The first part of the book deals with methods of examination, and, as shown in Figures 392 and 393, in order to prevent the cover-glasses from resting on the amoebae, they were dropped on to a piece of moistened fine-meshed muslin (chiffon) and then covered. A good deal of information with regard to the food of the animals is followed by an account of the action of auxetics and kinetics upon them. On the third day after treatment with asparagin (auxetic) the whole medium was swarming with minute free forms. These lengthened, and in twelve days had quite altered their type, becoming very long and slender. When creatine (auxetic) and choline (kinetic and augmentor) were used, it was found that the choline stimulated multiplication very rapidly. During prolonged work it was discovered that normal forms, when grown with augmented auxetics, became what is called "the radiosa type," consisting of a central body with long, blunt pseudopodia. In Type 2, which is the rarer (see Figure 391), the pseudopodia were very much longer, and thinned out to fine filaments. The second part of the book is occupied with the results of experiments on the causes of excystment and excystation. The third deals with the preparation of cultivations, consisting of one species of amoeba with a pure strain of bacterium. Incidentally, it is shown that amoebae prefer certain bacteria as food. The last chapter consists of the description of a parasite of amoeba which was discovered by Mr. Drew. It consists of a peculiar black diamond-shaped body, with a central dot, which moves sluggishly about in the endoplasm of the animal; and, while the volume was in the press, it was found possible to infect cultures of an amoeba obtained from pond water, and apparently also two flagellate infusorians. The parasite appears to be a large *Micrococcus* resembling *M. ochraceus.*

W. M. W.

BOTANY.

The Story of Plant Life in the British Isles.—By A. R. HORWOOD, F.L.S. Volume II. 358 pages. 78 illustrations. 8-in. × 5-in.

(J. & A. Churchill. Price 6/6 net.)

In the Spring we were pleased to give a word of praise to the first volume of Mr. Horwood's book, and now the second

Figure 391. Radiosa type No. 2 of Amoeba [illegible] [illegible] 0·5 per cent. and [illegible] per cent.

Figure 392. [illegible]
The specimens are lying between [illegible] which are suitable [illegible]

(From "Researches in [illegible] Amoeba [illegible] Mr. [illegible]

Flatters & Garnett.

FIGURE 394. Rockrose (*Helianthemum vulgare*).

J. H. Crabtree.

FIGURE 395. Honeysuckle (*Lonicera Periclymenum*).

(From "The Story of Plant Life in the British Isles," Volume II, by A. R. Horwood, F.L.S. By the courtesy of Messrs. J. & A. Churchill.)

nes before us. It is, in the main, on the same lines as its predecessor, and the subjects are treated in the same attractive manner. It is true that a carefully written introduction deals with the working of the plant, or, in other words, physiological botany; but, when dealing with the types chosen, much information of a more general character is introduced, as we had occasion to mention. We are told, for instance, that the colour of the ribbon of the Legion of Honour was taken from the poppy by the Empress Charlotte of Austria; Tamarisk is so called because it abounds near the River Tamaris, in Spain; there was a superstition that, if the sap of Dogwood were absorbed in a handkerchief on St. John's Night, it would secure the fulfilment of every wish.

The illustrations are as good as those in the first volume; two of the photographic ones we are permitted to reproduce here (see Figures 394 and 395). In the diagram labelled "Figure 3" a plant, which has been ringed, is shown with the leaf above the ring flaccid. The incision as shown is, however, so slight that it would appear only to have penetrated the bark. To cut off the water supply, it would need to go through that part of the wood which is still conveying water. A third volume will complete the work.

W. M. W.

CHEMISTRY.

Notes on Elementary Inorganic Chemistry.—By F. H. JEFFERY, M.A. 55 pages. $8\frac{3}{4}$-in. × 6-in.

(The Cambridge University Press. Price 2/6 net.)

These brief notes, forming a lecturer's headings, are essentially a compact skeleton, which it is intended that the learner shall clothe. They embody summaries of facts and reactions, which the student will meet in the course of his first steps, and may usefully be made the basis of a preliminary training in the theory of analytical chemistry. They will require supplementing, however, by the teacher or a chemical handbook. The book is well printed, with section headings in bolder type, but it has a fault which no book should possess—it lacks an index.

C. A. M.

HISTORY.

The War in the Peninsula.—Some Letters of Lieutenant Robert Knowles, of the Royal Fusiliers, a Lancashire Officer.—Arranged and annotated by his great-great-nephew, SIR LEES KNOWLES, Bart. 92 pages. 1 plate. 4 maps. 8-in. × $5\frac{1}{2}$-in.

(Simpkin, Marshall & Co. Price 2/6.)

At the present time, when we are continually hearing what soldiers serving with the British Expeditionary Force have to say, there is a particular interest about the letters which were written a hundred years ago by a young Militia officer, Robert Knowles, who volunteered for active service with the 7th Fusiliers in Spain during the Peninsular War. Many things have changed since then; postal arrangements are very different, and the wounded are not left without money to perish from want, but the bravery of British soldiers is the same as it was then.

One of the most striking descriptions in the book is that of the Siege of Badajoz. During this Lieutenant Knowles and his men were the first to capture part of the defences, namely, Fort St. Roque. The officer's sword was broken into a hundred pieces, and his hand was bruised, but otherwise he was unhurt. At Salamanca, however, he received a musket-ball in his left arm, and some months later, when he rejoined his regiment, after acting as Adjutant for some time, he was unfortunately killed in the Mandechari Pass. We congratulate Sir Lees Knowles, his great-great-nephew, on the publication of the Letters, and on the way in which he has connected them together with explanatory matter.

W. M. W.

HISTORY OF SCIENCE.

Roger Bacon Essays.—Contributed by various writers on the occasion of the Commemoration of the Seventh Centenary of his Birth. Collected and Edited by A. G. LITTLE. 426 pages. 6 figures.

(The Oxford University Press. Price 16/- net.)

There is some doubt as to the date of Roger Bacon's birth, but 1214 is the most probable year, and the present year, therefore, has been chosen to do due honour to his memory. Remembered for long merely as a magician, he has now been given his rightful position in the history of science—as the first to realise the true nature of scientific method—as a synthesis of mathematics and experiment. The volume under review is one more evidence of the growing recognition of the value of the history of science, a knowledge of which is essential to a complete understanding of science as it is to-day.

Fourteen essays—eight in English, two in French, and four in German—are here contributed, dealing with different aspects of Roger Bacon's life, work, and influence. The volume opens with an excellent "Life" by the Editor, Mr. A. G. Little, M.A. The chief new point brought to light is that Bacon was not imprisoned during the years 1256-66, as is usually supposed, but was ill, the mistake having arisen through a misunderstanding of a passage in the "Opus Tertium." This is followed by an essay, dealing with the influence of Grosseteste on the direction of Bacon's studies, by Dr. Ludwig Baur; whilst in the next essay M. François Picavet deals with Bacon's position amongst other philosophers of the thirteenth century. The fourth essay, which is by Cardinal Gasquet, is entitled "Roger Bacon and the Latin Vulgate." Cardinal Gasquet points out the importance in which Bacon held the necessity of Biblical revision and the firm grasp he had of the principles of the whole subject. Bacon's philology and mathematics fall for treatment in the next two essays, contributed respectively by Dr. S. A. Hirsch and Professor D. E. Smith. As the latter writer points out, it is not in the extent of his knowledge of mathematics, but in his grip of its principles as applied to science, that Bacon's claim lies to be considered a great mathematician. Bacon's physics are dealt with in the next four essays by Drs. E. Wiedemann, S. Vogl, J. Würschmidt, and Professor Pierre Duhem. Then follows an essay on his relations to alchemy and chemistry by Mr. M. M. P. Muir. There is an error in this essay on page 313, when the author writes: "In 'De Arte Chymiae,' he [Bacon] regards silver as a kind of lead burdened by imperfections." The words "silver" and "lead" should here be transposed. Moreover, the claim made for Bacon by Mr. Muir, that "the method of observation and experiment, and reasoning on the results obtained, . . . led him to the invention of instruments of much usefulness in optics, astronomy, and other branches of physical science," is surely one that goes beyond the facts. Bacon's speculations as to the marvels that might be accomplished by science and art can hardly be called inventions. In many respects, however, this essay is particularly interesting, especially as concerns its criticism of the alchemistic doctrine of "primary matter," and its prevalence nowadays in a disguised form. The following essay, by Lieut.-Colonel H. W. L. Hime, entitled "Roger Bacon and Gunpowder," is taken from the author's "Gunpowder and Ammunition" (though this is not stated in the present volume). It brings forward evidence for believing Bacon to have been the discoverer of gunpowder, and attempts a solution of the cryptogram in which, it is believed, he concealed this discovery. The next essay, by Mr. E. Withington, deals with Bacon's medical knowledge and views, and is followed by one, by Sir J. E. Sandys, entitled "Roger Bacon and English Literature."

The volume closes with a bibliography contributed by the Editor. It forms a most interesting and instructive work, of great value to all students of the history of science.

H. S. REDGROVE.

NOTICES.

LONDON COUNTY COUNCIL LECTURES.—The following is a list of the free lectures which will be given during the month of November at the Horniman Museum, Forest Hill, S.E., at 3 o'clock: 7th, "Fossils and how they are Formed," Mr. E. A. Martin, F.G.S.; 14th, "The Folk-lore of Deep-sea Fishing," Mr. Edward Lovett; 21st, "The Origin and History of Bells," Mr. A. R. Wright; 28th, "Colours and Markings of Animals, II," Mr. H. N. Milligan.

THE ROYAL PHOTOGRAPHIC SOCIETY. — On Wednesday, October 21st, there was opened at 35, Russell Square, a House Exhibition of Photographs by Mr. Lewis Balfour, of "Bird Life on the Bass Rock." There are upwards of one hundred of these pictures, showing the various sea birds and incidents in their lives. The public will be admitted free daily, from 11 a.m. till 5 p.m., until Saturday, November 28th.

THE MANCHESTER SCHOOL OF TECHNOLOGY.—The School possesses particulars of more than five hundred and fifty students who were in attendance at the College during the academic year 1913–14, and who are now serving in various branches of His Majesty's Forces. With a view to the completion of a Roll of Honour, which shall also include the names of past students engaged upon military service, the Registrar will be glad to receive any information from such persons themselves or from their relatives or friends.

MR. MURRAY'S QUARTERLY LIST.—Among the forthcoming works announced in Mr. Murray's List we find the following, which will be of special interest to our readers: "A Hunter-Naturalist in the Brazilian Wilderness," by Theodore Roosevelt; "Emma Darwin (Mrs. Charles Darwin): A Century of Family Letters, 1792–1896," edited by her daughter, Henrietta Litchfield. The work includes letters by Mrs. Charles Darwin's mother, and the second volume contains many unpublished letters of Charles Darwin; "Trees and Shrubs Hardy in the British Isles," by W. J. Bean; and "Life Histories of American Game Animals," by Theodore Roosevelt and Edmund Heller.

POULTRY-LAYING COMPETITION. — The Utility Poultry Club have issued the result of the poultry-laying competition which has been carried out at the Harper Adams Agricultural College, Newport, Salop. The records for the six leading pens are as follows:—

Order.	Pen No.	Breed.	Total for 11 months. Eggs.	Value. £	s.	d.
1	6	White Wyandottes	1173	6	6	8¼
2	38	White Leghorns	1207	6	3	10¾
3	18	White Wyandottes	1084	6	0	10¾
4	2	White Wyandottes	1198	6	0	9½
5	39	White Leghorns	1179	6	0	3
6	35	White Leghorns	1186	5	18	8¾

THE ZOÖLOGICAL SOCIETY'S GARDENS.—The registered additions to the Society's Menagerie during the month of September were one hundred and thirty in number. Of these fifty-six were acquired by presentation, fifty-one by purchase, eleven were received on deposit, six in exchange, and six were born in the Gardens. The following may be specially mentioned: One White-bearded Gnu (*Connochaetes albojubatus*), born in the Menagerie on September 28th; two Grey-tailed Fruit-Pigeons (*Osmotreron griseicauda*), from Java, new to the collection, presented by the Marquess of Tavistock, F.ZS., on September 18th. A collection of birds from New Guinea, the Aru Islands, and so on, acquired by purchase on September 11th, and containing Greater Birds-of-Paradise (*Paradisea apoda*), a Lesser Bird-of-Paradise (*P. minor*), King Birds-of-Paradise (*Cicinnurus regius*), and the following species new to the collection: One Fairy Bluebird (*Irena turcosa*), from Java; two Blue-eyed Ravens (*Macrocorax fuscicapillus*); one New Guinea Pitta (*Pitta novae-guineae*); three Duperrey's Megapodes (*Megapodius duperreyi*), from the Aru Islands; and two Pied Egrets (*Notophoyx flavirostris*), from South-west New Guinea.

THE SCHOOL GARDEN MONTHLY.—From Dublin comes the first number of *The School Garden Monthly*, which will devote its efforts to promoting school gardening in Ireland. It is intended to inculcate a desire to improve the home surroundings, to provide healthful exercise for the body and mind, to train the young scholar in the first principles of citizenship by giving him the responsibility of ownership and respect for public property, and for the rights of others, while throughout and at all times to keep him in intimate touch with Nature as the ultimate source of all knowledge and beauty of the world. There is every reason why teachers in England should take advantage of this paper. The botanical side will be watched over by Mr. David Houston, well known for his pioneer work in Essex; Professor Henry will deal with trees; Professor Grenville Cole will write on the physical features of the country and on soils; and Professor Carpenter on zoölogical subjects. The practical gardening will be looked after by the School Gardening experts of the Irish Department. The price of the journal is one penny monthly (publishing office, 12, D'Ollier Street, Dublin). It is well illustrated and printed, and the first number contains: "The Story of a Bulb," articles on "The Garden and the Countryside in October," an illustrated account of a "School Garden," and Notes on Vegetables for Winter and Spring, as well as the Planting of Fruit Trees. The last page is headed "Playtime," and appeals strongly to young people.

THE ALCHEMICAL SOCIETY.—The fourteenth General Meeting of the Alchemical Society was held at 1, Piccadilly Place on Friday, October 9th, at 8.15 p.m., when the Honorary President, Professor John Ferguson, LL.D., and so on, of Glasgow University, delivered his presidential address for the session, dealing with the work entitled "The Marrow of Alchemy." The work, said Professor Ferguson, a poem in two parts or seven books, appeared in London in 1854–55 in a small octavo volume. The authorship is usually ascribed to George Starkey, who is said to have been a native of Bermuda, a graduate in arts, and a practitioner in medicine and pharmacy, though there is some doubt as to whether he really wrote it. The poem professes to give an insight into the mode of transmutation of "base" metals into silver and gold. The author first tries to prove that metals grow from seeds, and then relates some of his own experiences in alchemy, following this up by a so-called "pedigree" of the metals. The second part of the book contains practical directions concerning furnaces and other apparatus, the material to be employed, and so on, under confused symbolic names, closing with a sort of recapitulation. But, with all the help possible, it is not easy to see how the multiplication of precious metal is effected, or even what is obtained; and the lecturer suggested that, if the subject of the book were stated in the ordinary language of chemistry, it would probably be found that all the reäctions are familiar, and that the gold apparently obtained was only the gold used in preparing the so-called philosopher's stone, and that the deep, enshrouding mystery was due to the operator not knowing what he was doing.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

DECEMBER, 1914.

METEOR ORBITS.

By THE REV. M. DAVIDSON, B.A., M.Sc., F.R.A.S.

THE discovery of the relationship between comets and meteors may now be considered as one of the established truths of astronomy. Our periodic meteors are the *débris* of ancient comets, now largely disintegrated, whose material has become distributed around their orbits. When the Earth in its annual path passes through a portion of this *débris*, the particles are ignited by friction with our atmosphere, and a shower of meteors is the result. The question of the origin and nature of the cosmical clouds which finally give rise to meteors, whether materials expelled from some distant stars or fragments of matter escaping absorption into larger bodies, is one beyond the limits of this present article. We shall assume the existence of these in stellar space, and proceed to show how it may be possible for them to suffer a certain amount of disintegration, so that finally a meteor stream is the result.

Let us assume a number of particles, of uniform mass and density, equally distributed in a certain space, and the average distance between any two $2a$. If we imagine a large number of such bodies forming a sphere of unconsolidated matter, the attraction at the surface of this sphere can be represented by $\frac{\Sigma m}{r^2}$, r being the radius of the sphere. The number of particles is $\frac{r^3}{a^3}$, so that $\Sigma m = m\frac{r^3}{a^3}$. Hence the attraction at the surface is $m\frac{r}{a^3}$.

Now let us assume that the centre of such a sphere moves to a point distant R from the centre of the Sun. The attraction of the latter on the near side is $\frac{M}{(R-r)^2}$, and on the centre $\frac{M}{R^2}$; the difference is $\frac{M(2Rr-r^2)}{R^4-2rR^3+R^2r^2}$. If r is small compared with R, this reduces to $2M\frac{r}{R^3}$. If disintegration is to occur, then $2M\frac{r}{R^3} \quad m\frac{r}{a^3}$, or $\frac{2M}{R^3} \quad \frac{m}{a^3}$.

Suppose we take R to be one astronomical unit and $2a$ to be six feet. Substituting the values for M and R, we easily find that m cannot be less than sixteen grains, if disintegration is not to ensue. This example will show how a nebulous mass may be broken up by the action of the Sun.

There is another way in which disintegration can occur. It is now known that light-waves exert a pressure upon objects on which they fall. It was pointed out by Maxwell in 1873 that this should take place in accordance with his electromagnetic theory. In 1900 Professor Lebedew announced that he had isolated and measured the light-force, and other physicists followed with various experiments, which firmly established the existence of radiation pressure. While this pressure is very small, it is yet able to exercise an appreciable influence upon minute bodies. Thus the Earth

experiences a pressure of about seventy-five thousand tons; but since the ratio of light-pressure to gravitation pull increases as the linear dimensions decrease, a point is reached at which the former prevails. This can only take place when the particles are very small—about the thousandth part of a millimetre in diameter.

Professor Poynting has taken the case of a dark particle of density 5·5, and the thousandth of an inch in diameter. Under these circumstances he shows that the radiation pressure is about one hundredth of the pull exercised by the Sun, and the periodic time of such a particle would be increased from three hundred and sixty-five and one quarter days (assuming its original period the same as that of our Earth) to about three hundred and sixty-seven days. Again, there is heat radiated by such a particle, and the radiation pressure is greater on the front than on the rear, for the frequency of the vibrations is raised in accordance with Doppler's principle; hence the particle tends to spiral inwards towards the Sun. Thus, as Professor Poynting shows, "a comet of particles of mixed sizes will gradually be degraded from a compact cloud into a diffused trail lengthening and broadening, the finer dust on the inner and the coarser on the outer edge."

If we take the case of a meteor stream where the particles have been drawn out along its track, an orbit originally elliptical will tend to become circular through the Doppler effect. Hence there seems the possibility of certain streams which once lay outside the orbit of the Earth being drawn in; and if they encounter the Earth new meteor radiants are observed.

There are ancient records of comets which were seen to break up into fragments. Thus Seneca relates that Ephoras mentions a comet which divided into two portions before disappearing. In 1618 two comets appeared in the same part of the heavens, and were probably fragments of a comet that had broken up. In the winter of 1845–6 Biela's comet separated into two parts, and these two distinct portions were visible when it returned to the Sun in 1852. As the comet did not appear in 1865 and in 1872, a meteoric shower was expected from its *débris* about November 27th, this being the date when the Earth would encounter its fragments. The display of shooting stars on November 27th, 1872, was remarkable, and on comparing the orbit of the stream, deduced from a knowledge of the radiant, with that of Biela's comet, the two were found to be practically identical. The elements of each are given at the end of this article, their similarity being apparent.

We shall now consider the case of a few other meteor streams. On January 2nd and 3rd there is a shower from a point in the heavens near R.A. 15h 20m, Declination 52° N. This shower was seen last year by Mr. C. L. Brook, Meltham, Yorkshire, and by Mr. Denning, of Bristol. The present writer worked out an orbit, the elements of which are given at the end, and also made a model of their orbit and that of the Earth. These are shown in the first figure, where it will be seen that the Quadrantids move with a great inclination to the plane of the ecliptic, and also that the Earth intersects the stream very close to its perihelion, P. No comet is known which corresponds with this shower: it is probably the remains of one long since disintegrated (see Figure 397).

The Leonids are most active on November 13th and 14th, and were seen last year by some members of the British Astronomical Association, including Miss A. G. Cook (Stowmarket) and Mr. and Mrs. Wilson (Bexley Heath); they were also seen at the Royal Observatory, Greenwich. The radiant for this shower is at R.A. 10h, Declination 23° N. The model shows the orbit, and the connection between the Leonids and Tempel's comet is obvious by comparing their elements. This shower was very active on November 14th, 1833, and ten returns of the same shower were found on enquiry to have occurred before 1799. The fact that the great displays had taken place at intervals of about thirty-three years, or some multiple of this period, led to an expectation of a brilliant shower in 1866. It recurred with considerable brilliancy, though less than in 1833. The particles composing this stream are concentrated at one portion of its orbit, and our Earth encounters this part every thirty-three or thirty-four years, unless it suffers considerable perturbations from Jupiter, as in 1899. The particles are also drawn out along the orbit, though they must be greatly scattered, as the shower is not abnormally rich in ordinary years (see Figure 398).

The Geminids are active about the middle of December. Last year a shower was observed by Mrs. Wilson, a well-known astronomical worker. The radiant was near β Geminorum. It will be seen from the photograph of the model that the particles composing this stream pass near the Sun at perihelion, their distance being under two millions of miles. There is no comet whose orbit corresponds with that of the Geminids (see Figure 396).

Other important showers may be mentioned, such as the Lyrids, whose orbit is like that of the first comet of 1861, though it cannot be definitely established that they are the *débris* of this comet. The Perseids are identified with the third comet of 1862, known as Tuttle's. The elements of these two orbits are nearly the same (see No. 6 of the list).

Enough has been said to show that there are many interesting problems opened up in connection with meteoric astronomy, and a fruitful field of work is open to those who have the time and inclination for this particular sphere.

The elements of the orbits of some meteor streams, and also of comets, are given below.

Figure 396.

Figure 397.

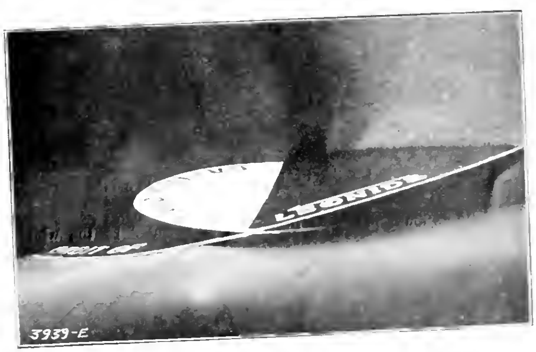
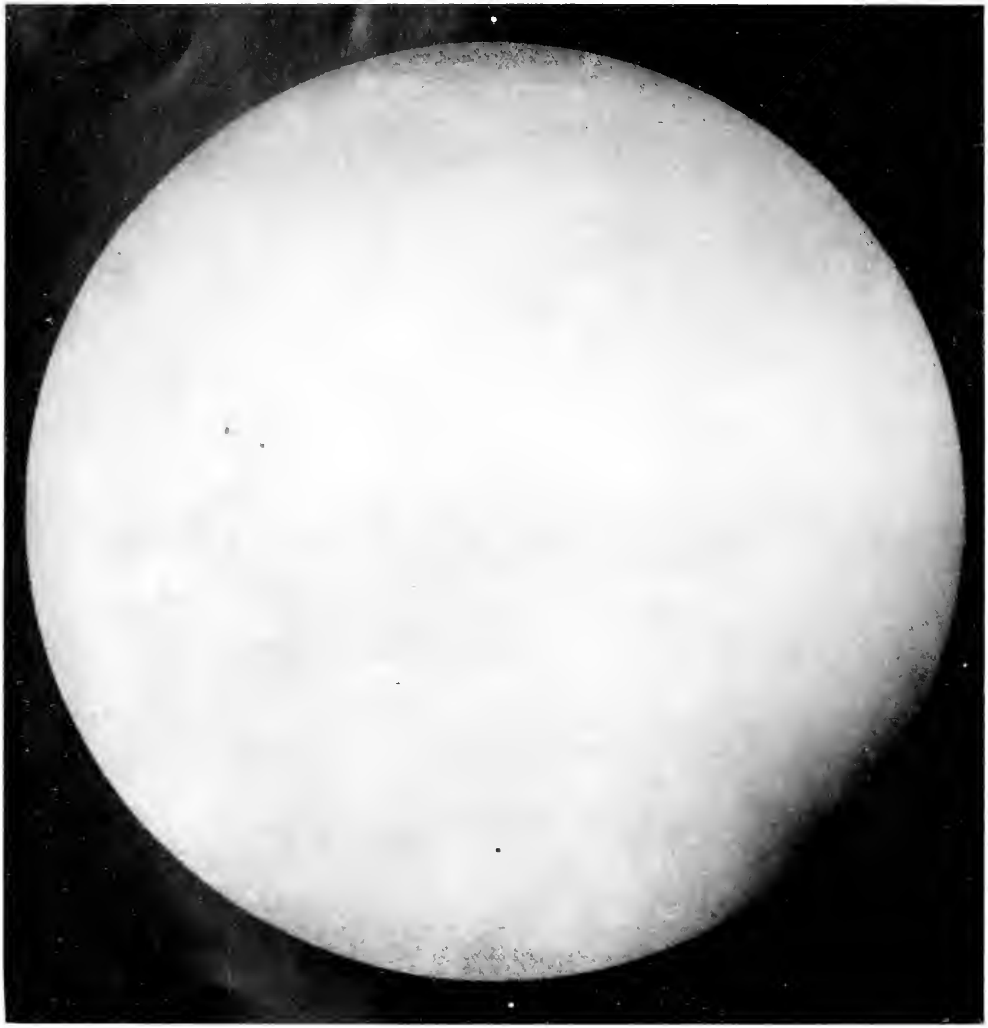


Figure 398.



From a photograph by *F. W. Barlow.*

FIGURE [illegible]. Transit of Mercury, November 7th, 1914.

The North and South points of the Sun are indicated by the white dots.

See page 419.

METEOR STREAMS.

No.	Radiant.	ι	π	☊	q	Shower.
	° °	°	°	°		
1.	232 + 51	72·8	96·2	282	·981	Quadrantids
2.	149 + 22	164·6	47·5	232	·986	Leonids
3.	117 + 28	58·2	244·8	261·4	·021	Geminids
4.	24 + 45	17	110	244	·836	Andromedids
5.	272 + 33	79	248	32·5	·912	Lyrids
6.	45 + 57	114	291	138	·964	Perseids

The symbols have the usual significance :—

ι denotes the inclination to the plane of the ecliptic.

π denotes the longitude of perihelion.

☊ denotes the longitude of the ascending node.

q denotes perihelion distance in astronomical units.

Nos. 2, 4, 5, and 6 meteor streams correspond with comets Nos. 2, 4, 5, and 6 respectively.

COMETS.

No.			ι	π	☊	q	Comet.
2	...	...	162·7	60	231·5	·976	Tempel
4	...	...	12·5	109·1	245·8	·860	Biela
5	...	...	79·75	243·4	29·9	·921	1861, I
6	...	...	114·3	291·5	138·6	·957	1862, III

The Figures have been reproduced by kind permission of the Council of the British Astronomical Association.

CORRESPONDENCE.

RUSSIAN PEASANTS' ARITHMETIC.

To the Editors of "KNOWLEDGE."

SIRS,—The following proof may be given of the Russian mode of multiplication mentioned in your June issue.

Every number is of the form $2^{p_1} + 2^{p_2} + \dots + 2^{p_n}$, the indices being in descending order of magnitude, and p_n may be zero. Let the numbers to be multiplied be

$$a \text{ and } 2^{p_1} + 2^{p_2} + \dots + 2^{p_n}.$$

The product is, of course,

$$a(2^{p_1} + 2^{p_2} + \dots + 2^{p_n}).$$

Multiply a successively by 2 and divide the other number similarly by p_n times; we get

$$a \times 2^{p_n} \text{ and } 2^{p_1 - p_n} + 2^{p_2 - p_n} + \dots + 2^{p_{n-1} - p_n} + 1.$$

The right hand is odd, all the intermediate quotients being even.

Reject the 1 and multiply and divide by 2 as before $p_{n-1} - p_n$ times; we get

$$a \times 2^{p_{n-1}} \text{ and } 2^{p_1 - p_{n-1}} + 2^{p_2 - p_{n-1}} + \dots + 2^{p_{n-2} - p_{n-1}} + 1.$$

As before, the right hand is odd, the intermediate quotients being all even.

Reject the 1 and multiply and divide by $2^{p_{n-2} - p_{n-1}}$, and so on. Adding the left-hand products we get the final result as above.

HELEN A. S. ATKINSON.

SWANINGTON RECTORY,
NORWICH.

To the Editors of "KNOWLEDGE."

SIRS,—The explanation of the method used by Russian peasants for the multiplication of two numbers is as follows :

First, it is evident that, in a product which results from the multiplication of two factors, if the one be halved and the other doubled, the product is unaffected ; what is lost by the one is gained by the other. In the process under discussion, therefore, if the left-hand factor be even, the net result of the immediately following operation upon the product is nil. If the left-hand factor be odd, the immediately subsequent operation results in a product which is less than the original required product by once the right-hand factor. In the final addition this loss is made good by the reïnclusion of any number in the right-hand column which stands opposite to any such odd factor in the left-hand column.

To take a concrete example, say the first of those given by your correspondent :—

25	11	....	1
12	22	....	2
6	44	....	3
3	88	....	4
1	176	....	5

Line 2 is the original product (line 1) less the odd (25th) eleven, the first 24 elevens being equivalent to the 12 twenty-twos of line 2.

Line 3 is the exact equivalent of line 2, which may therefore be crossed out, line 3 being left in its place.

Line 4 is the exact equivalent of line 3, which may therefore be crossed out.

Line 5 is the equivalent of line 4, less the odd (3rd) eighty-eight : this is itself the equivalent of line 1 (the required product) less 11.

Hence the required product is line 5 + 88 + 11.

GEORGE N. HIGGINSON.

42, BARTHOLOMEW ROAD, N.W.

THE TRANSIT OF MERCURY, NOVEMBER 7TH, 1914.

FIGURE 399 is from a photograph which was taken at Bournemouth with a 4½-in. refracting telescope with camera attachment, the exposure being about one-thirtieth of a second, a lantern plate being used as negative, and yellow screens employed to reduce the intensity of the light. Save just at the beginning of the transit, the Sun was never quite free from cloud, very light cirri at first, and gradually getting thicker, the definition being consequently only moderate. In the telescope at the moments of best definition the planet appeared quite sharply defined and clear-cut against the mottling of the solar granulation. There was no light-halo round the planet or any light-spots on it such as have sometimes been recorded. The "black drop" was seen for a few seconds [illegible] definition being then good, in spite of fairly thick cloud. The obscuration of part of the Sun's edge in the photograph is due to cloud. In comparing the relative sizes of the Sun and Mercury it must be remembered that the planet is considerably nearer us than the Sun, so that it looks proportionately larger. Two small spot-groups are visible.

E. W. BARLOW, B.Sc. (LOND.), F.R.A.S.

THE SPINNING OF A WEB.

By FRANK CUTTRISS.

A heavy thunderstorm in the afternoon having completely destroyed and washed away every trace of the web which a half-grown female garden spider had made amongst the pines on the previous day—night, we should perhaps say, as we had arrived on the scene at midnight, just as she was completing it—we considered the circumstances favourable for carrying out a project we had long had in mind, that of watching the construction of a spider's geometrical web from start to finish.

By early evening the storm had passed, leaving the earth sodden, and the pine foliage sparkling with innumerable raindrops; thunder rumbled all around, while the clouds were still very heavy and threatening, and we were a little doubtful if the weather would permit us to keep our vigil.

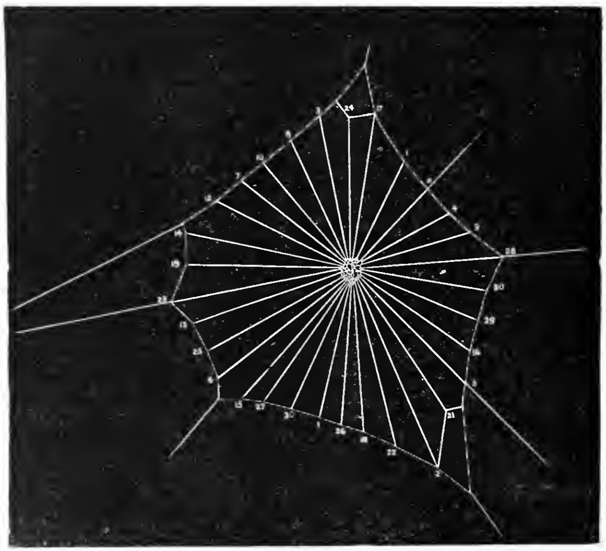


Figure 400.

Diagram showing the order the radial lines of the web were fixed.

At seven o'clock the spider lay close to the underside of the branch which it had chosen for its home. One could fancy it had foreseen the occurrence of storms, for no more perfect shelter could be imagined, the branch keeping off direct rain and the foliage around conducting all water away from the spider.

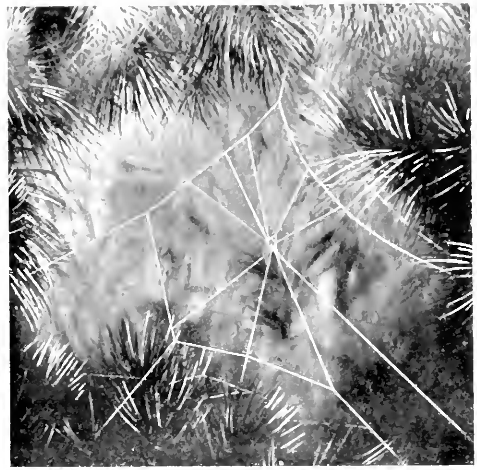
At half-past seven, at eight o'clock and half-past eight, when we visited it, no movement had occurred, and it appeared as though our trouble would be unrewarded.

We felt certain, however, that if it were likely to remain fine all night, with the prospect of a fine morning, the spider would appreciate it, and, by about midnight, construct a new web for the morrow.

Nine o'clock came, and, although the clouds were as dense and stormy-looking as ever, we decided to visit our friend again and see what it was thinking. This time we were rewarded, for just as we reached the spot it left shelter, came out to the tips of the foliage, dropped down a line to a point a few inches below, ascended to about midway, turned head downward, and remained suspended for about fifteen minutes (see Figure 401). It then ascended to its nest branch, and in a few minutes descended to a branch below. Five seconds later it ascended to its original position, taking up the line with it, so that at 9.25 p.m. practically nothing visible had been done.

Ten minutes later it again emerged, descended to a branch below, and made fast a line, which eventually formed two of the perpendicularly radiating lines. Ostensibly, therefore, the spider commenced the real business of making its web at 9.35 p.m. Next, from the tips of the foliage of its nest branch it let loose a long line with a free end, the object of which soon became apparent; for in a few seconds it became attached, at an angle of about forty degrees, to foliage on the lower left hand. Here the instinct—or reason—of the animal especially arrested our attention, as at the time the wind was blowing from the right, directly in line with the position selected for the web, so that in very few seconds the floating thread streamed out and was caught as described. Practically from no other point than that chosen by the spider for setting loose this line could the end in view have been attained.

We now conjectured a speedy completion of the structure, mentally allowing about an hour for the work. We reckoned, however, without our entertainer, for after having done a certain amount of groping about among the foliage in the vicinity



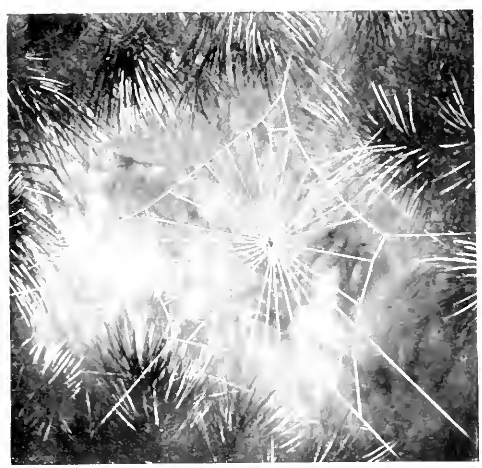
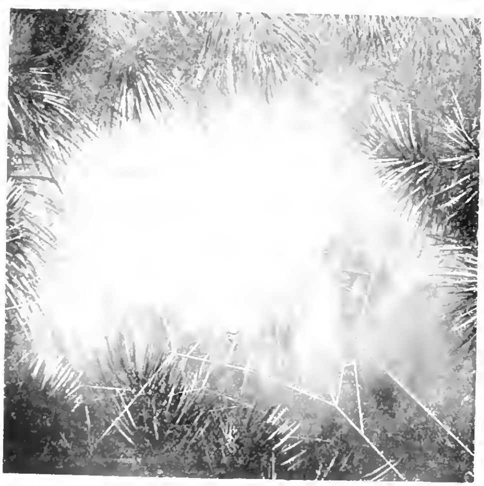
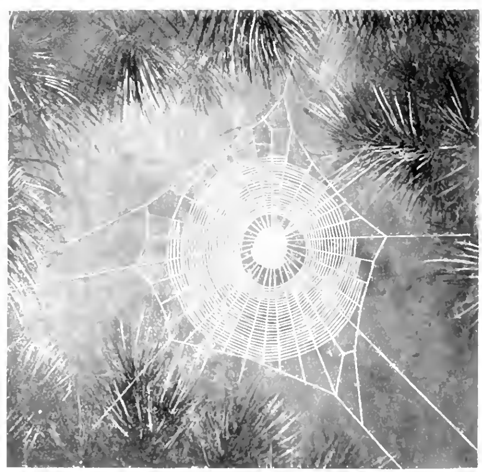


Figure 407. 12.50 a.m.





the net result at 9.50 (see Figure 402) was a rough framework, two upper and two lower lines radiating from a nebulous sort of ring, which was evidently determined upon as the centre for the coming web The architect now settled herself comfortably, head downward, at the junction, and took a long rest. Twenty minutes elapsed, and our spinner appeared suddenly to realise that time was going on, and set to work again, until at 10.27 p.m most of the supports were fixed, and nine of the radiating lines were in position (see Figure 403). The spider now ascended to the nest branch, and for a considerable time crept about amongst the foliage. At 11.10 p.m. it descended to the centre, and remained there, head downward, for five minutes; at 11.15 it was again stirring, until at 11.37 the right-hand support or border line had been fixed as well as twenty-two of the radial threads. The twenty-seventh radius was fixed at 12.3 a.m., after which the spider returned to the centre and remained head downward (see Figure 404).

In every case where we say rested or remained in centre of web, or elsewhere, we do not wish to convey the idea that the spider did absolutely nothing during the time, although for the most part no movement was noticeable.

At 12.30 a.m. (see Figure 405) the last of the thirty-one radial threads was in position, the accompanying numbered diagram showing at a glance the order in which they were made (see Figure 400). A short space of time between the placing of all the radii after the twenty-seventh was devoted to netting together at centre and fixing roughly concentric threads over larger or smaller segments, which the little creature accomplished by travelling to and fro, stopping momentarily to fix the thread as it went, the greater part of the central work being done after the fixing of the twenty-ninth radial.

A few seconds after this the spider commenced one of the most wonderful of the many astonishing features of geometric web-spinning, inasmuch as it apparently demonstrates foresight and the possession by the spider of reasoning powers which enable it to use the best means to accomplish the end in view. It affixed a thread near the right upper centre, then by supporting itself on the radial threads and working towards the left it affixed its thread—always one remove back—in a beautiful volute of about two and three-quarter turns, which was completed at 12.40 a.m. (see Figure 406).

The objects of this helical line, it afterwards became evident, were to keep the radiating threads properly taut and at the intended distances apart; also to some extent as a scaffold for the construction of the concentric portion of the web.

At 12.41 a.m. the outermost of the concentric threads was placed by the spider, working from the top towards the left, and upon arriving at the intended limit on the right it turned about and commenced the second thread, working towards the left by way of the bottom of the web.

At 12.48 a.m. four of these threads had been fixed, the spider accomplishing the work by climbing up two threads ahead, descending to just the right distance from the thread last fixed, bending its abdomen over the radius next to it, making a decided pause, and with the spinnerets getting the thread, which had exuded as it proceeded, fixed at exactly the right spot, holding the section just fixed with the hind foot on that side so that it should bear the strain during the operation; then up the next radius, and so on, over and over again (see Figure 407).

Given a good illumination through the web, the most superficial observer would by this time have noticed that a very short time after each division of a concentric was fixed, it changed in appearance from the finest streak of reflected light to an apparently stouter and whiter line, and would recollect that none of the other lines—supports, radii, or central netting—underwent any such change. Upon closer examination and magnification this would be found to be caused by the running together into globules of a viscid matter, the result probably of the spider intentionally bringing into action a special secretion. We carefully noted the time elapsing between the fixing of a thread and the completion of the studding with viscid globules, and found it in every case to be exactly fifty seconds.

The spider now kept on steadily at work, the only variation in its movements occurring with the completely circular threads, all of which were fixed by the spider working in one direction only (from left to right) instead of turning about as at the end of an incomplete circle and working the next in the opposite direction.

Excepting when descending on a line, the spider appeared in every case to draw out the thread from its spinnerets by means of its hinder feet used alternately, while the temporary volute or helical thread was cut away, apparently by its fore feet, as the spider reached it in fixing the permanent concentric lines.

At 1.25 a.m. the finishing touch was given to one of the most perfect webs we have seen (see Figure 408), and the little wonder-worker glided up a line connected with the intricate network in the centre and took up its position to watch and wait on the underside of the branch, the shelter of which it had left nearly four and a half hours earlier.

The web constructed by this spider on the previous night—preceding the storm—had two stay lines attached, one on either side near the centre, which were affixed to the foliage about four or five inches away.

The web we saw constructed had no stay lines, the succeeding day being calm and without rain. We noted these facts incidentally, but would consider it unwise in the absence of recurring confirmatory observations to attribute them to either premonition or coincidence.

In connection with the construction of geometrical

webs it is interesting to note that, although the foregoing spider on three consecutive days made webs, each of which contained the same number (thirty-one) of radii, there appears to be nothing to determine the number of these radiating lines that any particular spider will make. Perhaps we ought rather to say that the factors determining such are at present beyond our knowledge.

An *Aranea umbratica* which we had under observation at the same time as our friend *diademata* constructed—also at midnight—a web twelve inches in diameter. This, while much larger than that of the garden spider, was much more open in structure —a characteristic of this species—and contained twenty-two radii only, which at the outside of the web were necessarily so much further apart than those of *diademata* as to render it difficult to construct the outermost concentric threads. To obviate this difficulty the spider made a temporary helical line of six coils instead of the three, which, extending much nearer to the outer edge, enabled the spider to use it comfortably as a scaffold to get on to the next radius, along which it slipped foot after foot, precisely in the manner of a tit descending a cord, until in position for affixing its thread.

Again, the web of a *Zilla notata*, six inches only in diameter, had forty radiating threads, while a younger spider of the same species constructed a web, containing but twenty, across the mouth of a jug.

A vast field for research in this direction is open, and, although there is evidence of increasing interest in the ways of the much-maligned spider, it would seem that the fringe only of the subject has been touched, and it may well be said of it, as of everything else in Nature, that he who knows most concerning it knows best how little he knows.

SOME INTERESTING GRAFTS.

It is now common knowledge that the celebrated firm of James Veitch & Sons, to the enterprise of which horticulture owes many plants of which the names are now household words, is to come to an end. It is perhaps a wise decision of Sir Harry Veitch that, if it is not to be carried on by a member of the family, it were best that business should cease to exist. We are reminded that the firm in question, some years ago, made a series of experiments in grafting, at the suggestion of the late Professor Romanes, with a view to seeing whether any effects could be noted of stock upon scion, or scion upon stock. The plants chosen were woody ones, and the results were practically nil, though a very interesting series of combinations was produced and preserved at Coombe Hill Nurseries. Some of these are shown in the reproductions of photographs from which Figures 409 to 414 were taken.

THE TRANSIT OF MERCURY.

The transit of Mercury was observed here with various telescopes, both visually and photographically. The seeing was unusually good, and the planet was seen at ingress by the writer on the focusing screen of an astro-camera to show a marked "black drop" effect. There was no difficulty in perceiving this, as the planet's image was about one-eighth-inch in diameter on the screen, which received the image from a 0·9-in. Hughenian eyepiece, used as a projector on the ten-inch Cooke refractor.

There was no halo round the planet when carefully scrutinised. It is probable that the reputed halo is an illusion. With a two and three-eighth-inch Steinheil telescope the writer saw it to-day as he did also in 1907 with the same instrument and eyepiece at the University Observatory, Oxford.

Careful scrutiny with the ten-inch refractor and powers 180 and 300 failed to reveal it, and also failed to show any markings whatever on the planet, which, whenever well seen, appeared as a perfectly round, sharp black disc on the Sun. At egress the weather was misty; the disc, therefore, was suffused with a veil of sunlight, which was uniform, and evidently due to sky-glare. At egress the disc was distorted with the "black drop" phenomena, which, however, were both less marked and more difficult to see than at ingress, owing to lack of transparency. The seeing at times was as high as 6 on a scale 10, which is exceptionally good for daytime. The limb of the Sun was not as sharply defined as that of Mercury.

These observations provide conclusive, if negative, evidence about the reputed halos and white spots which have been reported on some former occasions.

About a dozen photographs were attempted. The most successful are, perhaps, those obtained with the ten-inch telescope, twelve-foot focus, with an eyepiece used as projector, giving an equivalent focus of about one hundred and eighty feet. But these lack definition, owing to the state of the atmosphere, and also to difficulties of focusing the visual combination. Other photographs with five-inch and one and a quarter-inch Sun also show the planet; but by far the most satisfactory view was obtained visually. In these observations Messrs. Bryant Baker, Robert Baker, W. H. Steavenson, and J. E. Maxwell assisted, and in these conclusions they concurred with the writer.

JAMES H. WORTHINGTON,
Four Marks Observatory,
Alton, Hants.

THE GAZETTE ASTRONOMIQUE.

It is proposed to recommence the publication of the *Gazette Astronomique*, formerly issued by the Astronomical Society of Antwerp. The occupation of that town by the Germans occasioned the temporary suspension of the *Gazette*, and many of its supporters have now found hospitable homes in this country. A number of English astronomers, on the initiative of Mrs. Fiammetta Wilson, of Bexley Heath, are interesting themselves in the matter by financial assistance and the promise of literary contributions.

It is intended to restart the *Gazette Astronomique* early in January in the French and English languages. The minimum subscription will be five shillings annually, but English astronomers who are able and willing to subscribe more liberally may send half a guinea or a guinea as a means of more effectively aiding their unfortunate allies in the attempt to revive their astronomical journal. It will be issued once a month, unless circumstances should enable it to appear more frequently. Subscriptions and correspondence should be sent to Félix de Roy, Honorary Secretary, 29, Stamford Street, London, S.E.

FIGURE 409. Grafting in the family Oleaceae.

In the left-hand specimen the stock is *Osmanthus*, and the scion *Phillyrea*. The right-hand specimen is Privet (*Ligustrum*) on *Phillyrea*.

FIGURE 410. *Eriobotrya* grafted on *Raphiolepis* (family Rosaceae).

FIGURE 411. The plants joined together here belong to the same family as those shown in Figure 409, namely, Oleaceae. They are *Phillyrea* grafted upon *Olea oleifolia*.

FIGURE 412. The Rose grafted on the Bramble (family Rosaceae).

FIGURE 413. This example shows two conifers grafted together, *Thuiopsis* on *Biota*.

FIGURE 414. The examples shown are Garrya and the spotted laurel (*Aucuba*—family Cornaceae). In the left-hand specimen the latter is the stock, but in the right-hand one it is the scion.

The specimens shown in Figures 409 to 414 were grafted by Messrs. James Veitch & Sons some years ago at the suggestion of the late Professor Romanes, and they have been grown at Coombe Hill Nurseries. (See page 424.)

b

c

a

FIGURE 415. (a) A secondary wing feather of an African Ground Hornbill. A longitudinal section has been made of the shaft, so that it is seen to be hollow throughout its length.
(b) and (c). Portions of another feather seen from above and below with the shaft obliquely cut through.

FIGURE 416. A primary wing feather of a Condor. In this the shaft has been laid open: above the quill it is shown to be solid and filled with a white pith-like substance.

FEATHERS WITH HOLLOW SHAFTS.

THE study of feathers is an interesting one, though there are few who take it up. In preparing a series of feathers for exhibition, illustrating their more interesting modifications, the writer made what he thinks is a little discovery. In all the textbooks the shaft, or rachis, of the feather is described as being solid. If one cuts through, say, the wing-feather of a goose, one finds that immediately above the hollow quill the feather is filled with a white pith-like substance. When examining the feathers of an African Ground Hornbill, it was found that the whole shaft from quill to the tip, even in the long-flight feathers, was hollow. In Figure 415 this is well shown, and Figure 416 represents a Condor's feather, of which a section has been made for comparison. Although many hundreds of kinds of feathers have been examined, a similar state of affairs has not been found in any others, except in the American Darter. There appear to be a small tube in the shaft of the Secretary Bird's wing-feather and a slight indication of one in one or two others. It would be interesting to hear whether our readers can throw any further light on the subject.

WILFRED MARK WEBB.

SOLAR DISTURBANCES DURING OCTOBER, 1914.

By FRANK C. DENNETT.

IT was found possible to observe the Sun every day during October. On six days (2nd, 6th, 13th to 16th) the disc appeared free from disturbance; only faculae were visible on nine others (3rd to 5th, 7th to 9th, 12th, 17th, and 18th), spots being seen on the remaining sixteen, though none were of great magnitude. The longitude of the central meridian at noon on October 1st was 223° 50′.

No. 31, belonging to the September list, remaining visible until October 1st, reäppears on the present chart.

No. 32.—A group of four pores, the largest being the leader, some fifty thousand miles in length, was noticed on the 10th; but only two remained the next day, when it was last seen. The region was marked by faculae on October 1st, 12th, and 29th.

No. 33.—A small spot, with four tiny pores nestled closely behind it. The whole group, not more than fifteen thousand miles in length, was seen on the 19th at 10 a.m. At 1.30 p.m. the spot contained two umbrae, and only two of the pores remained. On the 20th the spot was elongated, with six pores following it. When last seen on the 21st there were two pores leading in place of the spot and one at the rear. The area was marked by faculae on the 24th and 26th.

No. 34.—Two spotlets on the 22nd, perhaps five thousand miles in diameter, with pores between, some forty-two thousand miles from end to end. Next day the preceding umbra had become crescent-shaped, with a tiny black dot ahead like a Turkish crescent and star; a tiny pore south-east of the following spotlet slightly increased the length of the group. By the 26th it had assumed the form shown on the chart, with a length of sixty-seven thousand miles. Slight changes were noted on the two succeeding days, and when last seen on the 29th it consisted of one spotlet with three pores in front of it.

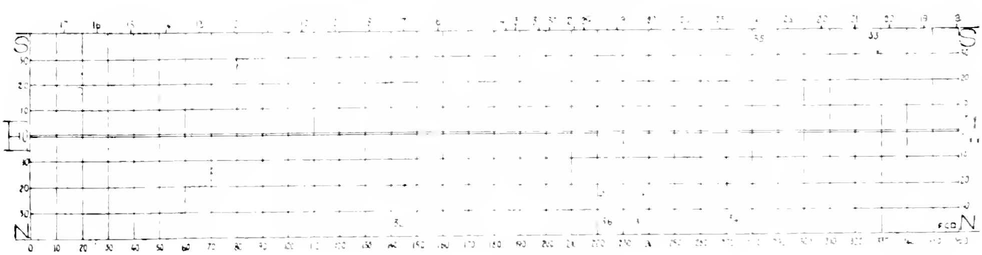
No. 35.—A pair of pores only seen on October 26th.

No. 36.—When first seen on the 26th there were four pores, a larger one with three smaller; the group nineteen was thousand miles in length. By next day the group had grown to about seventy thousand miles in length, consisting of pores, the one small spot being near the middle of its length on the northern side. The chart shows it on the 29th, but next day the rear component was enlarged. On November 1st two spots were visible, each having a pore behind it. Last seen as a spot with a facular cloud lying to the north-east on the 3rd.

Faculae were recorded near the limb west or *preceding* on October 3rd; north-west on 4th, 5th, 17th, 18th (long. 70°, N. lat. 24°) to 20th, remains of No. 29; north-east, 7th until 10th, the remains of No. 29; also faculae on 11th and 28th; south-west on 3rd (278°, S. 38°, and 265°, S. 20°), 18th, and 19th; south-east 1st (175°, S. 20°), 7th, and 8th (84°, S. 29°), the remains of No. 28; 9th and 10th, the remains of No. 30; 11th and 12th (19°, S. 19°); also near the limb some 20° distant from the North Pole, towards the west on October 1st.

Our chart is constructed from the combined observations of Messrs. John McHarg, E. E. Peacock, and F. C. Dennett.

DAY OF OCTOBER, 1914.



THE FACE OF THE SKY FOR JANUARY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 54.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A	Venus. Dec.	Vesta. R.A.	Vesta. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°
Jan. 1	18 43·5	S.23·1	6 44·1	N.26·9	18 33·3	S.24·8	15 57·9	S.16·1	4 34·2	N.17·7	21 40·5	S.14·9	5 51·1	N.22·3	8 6·6	N.19·9
,, 6	19 5·6	22·6	11 1·5	N. 4·6	19 8·7	24·4	16 9·4	16·5	4 30·8	17·9	21 44·6	14·5	5 49·4	22·3	8 6·1	19·9
,, 11	19 27·4	21·9	15 24·7	S. 24·0	19 44·4	23·4	16 23·1	17·0	4 28·1	18·1	21 48·9	14·2	5 47·8	22·3	8 5·5	19·9
,, 16	19 49·0	21·1	20 38·7	S. 20·3	20 20·0	21·7	16 38·7	17·6	4 26·1	18·3	21 53·2	13·8	5 46·3	22·3	8 4·9	20·0
,, 21	20 10·5	20·1	0 30·[illegible]	N. 7·9	20 55·0	19·4	16 55·9	18·3	4 25·0	18·5	21 57·5	13·4	5 44·9	22·3	8 4·4	20·0
,, 26	20 31·3	18·9	4 55·0	N.27·1	21 28·5	16·5	17 14·5	18·9	4 24·6	18·8	22 2·0	13·0	5 43·7	22·3	8 3·8	20·0
,, 31	20 52·0	S.17·6	9 8·[illegible]	N.17·6	21 58·7	S.13·1	17 34·2	S.19·4	4 25·0	N.19·1	22 6·5	S.12·6	5 42·6	N.22·4	8 3·2	N.20·1

TABLE 55.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Greenwich Midnight. Moon. P
	°	°	°	°
Jan. 1	− 2·2	−3·1	91·0	+ 5·9
,, 6	− 0·2	3·7	25·2	+21·8
,, 11	2·6	4·2	319·4	+12·0
,, 16	5·0	4·7	253·5	−15·3
,, 21	7·3	5·2	187·7	−21·7
,, 26	9·5	5·6	121·9	− 6·3
,, 31	− 11·7	−6·0	56·0	+17·1

Greenwich Midnight.	Jupiter. P	B	L_1	L_2	T_1	T_2
	°	°	°	°	h. m.	h. m.
Jan. 1	−21·2	+0·4	288·2	261·9	4 7 *e*	4 47 *e*
,, 8	21·5	0·4	311·7	232·0	3 29 *e*	5 36 *e*
,, 15	21·9	0·5	335·2	202·0	2 50 *e*	6 26 *e*
,, 22	22·2	0·5	358·6	172·1	2 12 *e*	7 15 *e*
,, 29	−22·6	+0·6	22·1	142·1	1 33 *e*	8 5 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}7$, $9^h\ 55^m{\cdot}8$ respectively.

For the future the data for the Moon and Planets in the Second Table will be given for Greenwich Midnight, *i.e.*, the Midnight at the end of the given day.

The letters *m. e.* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN has commenced to move Northwards; nearest Earth $2^d\ 6^h$ *e*. Its semi-diameter diminishes from 16′ 18″ to 16′ 16″. Sunrise changes from $8^h\ 8^m$ to $7^h\ 43^m$; sunset from $3^h\ 58^m$ to $4^h\ 45^m$.

MERCURY is an evening star from the 6th. Semi-diameter increases from $2\frac{1}{2}$″ to 3″. Illumination diminishes from Full to $\frac{3}{4}$.

VENUS is a morning star, at Greatest Brilliance on 2nd. Illumination increases from $\frac{1}{4}$ to $\frac{1}{2}$. Semi-diameter diminishes from 21″ to 13″.

THE MOON.—Full $1^d\ 0^h\ 20^m$ *e*. Last quarter $8^d\ 9^h\ 13^m$ *e*. New $15^d\ 2^h\ 42^m$ *e*. First quarter $23^d\ 5^h\ 32^m$ *m*. Full $31^d\ 4^h\ 41^m$ *m*. Perigee $12^d\ 2^h$ *e*. Apogee $24^d\ 9^h$ *m*, semi-diameter 16′ 21″, 14′ 48″ respectively. Maximum librations $5^d\ 5°$ E., $11^d\ 7°$ N., $18^d\ 6°$ W., $25^d\ 7°$ S., $31^d\ 5°$ E. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 56).

MARS is invisible; in conjunction with Sun Dec. 24th.

VESTA is in Taurus, $1\frac{1}{2}°$ North of Aldebaran on 5th. It is of the 7th magnitude, and visible with a binocular.

JUPITER is an evening star, in Capricornus, 2° North of δ Capricorni on 3rd. Polar semi-diameter 16″.

Configuration of satellites at 6^h *e* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.
Jan. 1	1	○	34		Jan. 13	42	○	13
,, 2	23	○	14		,, 14	421	○	3
,, 3	321	○	4		,, 15	4	⊙	23
,, 4	3	○	124		,, 16	42	⊙	1
,, 5	13	○	24		,, 17	321	○	4
,, 6	2	○	134		,, 18	3	○	214
,, 7		○	43	1●2●	,, 19	31	○	24
,, 8	1	○	423		,, 20	2	○	134
,, 9	423	○	1		,, 21	21	○	34
,, 10	4321	○			,, 22		○	1234
,, 11	43	○	12		,, 23		⊙	134
,, 12	4^3_1	○	2		,, 24	321	○	4

The following satellite phenomena are visible at Greenwich, all in the evening:—$7^d\ 4^h\ 48^m$ I. Oc. D., $4^h\ 56^m$

II. Oc. D.; $8^d\ 4^h\ 25^m$ I. Tr. E., $5^h\ 12^m$ I. Sh. E.; $9^d\ 7^h\ 15^m$ III. Sh. E.; $14^d\ 6^h\ 50^m$ I. Oc. D.; $15^d\ 4^h\ 48^m$ I. Sh. I., $6^h\ 27^m$ I. Tr. E.; $16^d\ 4^h\ 18^m\ 2^s$ I. Ec. R., $4^h\ 56^m$ III. Tr. I., $5^h\ 20^m$ II. Tr. E., $6^h\ 40^m$ II. Sh. E.; $17^d\ 6^h\ 51^m\ 23^s$ IV. Ec. R.; $22^d\ 6^h\ 9^m$ I. Tr. I., $6^h\ 43^m$ I. Sh. I.; $23^d\ 5^h\ 13^m$ II. Tr. I., $6^h\ 12^m\ 50^s$ I. Ec. R., $6^h\ 19^m$ II. Sh. I.

Eclipses will take place to the right of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN was in opposition December 21st, in Gemini. Polar semi-diameter $9\frac{1}{2}''$. Major axis of ring 46″, minor $2\frac{1}{4}''$. Angle P $-5°\cdot8$.

Eastern elongations of Tethys (every 4th given) $1^d\ 10^h\cdot1$ *e*, $9^d\ 11^h\cdot3$ *m*, $17^d\ 0^h\cdot4$ *m*, $24^d\ 1^h\cdot6$ *e*; of Dione (every 3rd given) $1^d\ 6^h\cdot1$ *e*, $9^d\ 11^h\cdot0$ *e*, $18^d\ 4^h\cdot0$ *m*, $26^d\ 8^h\cdot9$ *m*; of Rhea (every 2nd given) $3^d\ 5^h\cdot9$ *m*, $12^d\ 6^h\cdot5$ *m*, $21^d\ 7^h\cdot1$ *m*, $30^d\ 7^h\cdot8$ *m*.

TABLE 56. Occultations of Stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reappearance. Time.	Reappearance. Angle from N. to E.
1915.			h. m.	°	h. m.	°
Jan. 1	WZC 489	7·0	—	—	8 5 *e*	323
,, 2	A Geminorum	5·1	3 17 *m*	43	3 42 *m*	359
,, 2	μ^1 Cancri	6·2	8 22 *e*	55	9 9 *e*	329
,, 2	WZC 554	7·2	—	—	9 33 *e*	287
,, 3	WZC 616	6·6	—	—	9 37 *e*	277
,, 4	WZC 620	7·9	—	—	1 36 *m*	266
,, 6	37 Sextantis	6·3	0 47 *m*	76	1 35 *m*	352
,, 7	υ Leonis	4·5	2 49 *m*	158	3 51 *m*	277
,, 9	BD − 12°3785	7·0		—	3 15 *m*	325
,, 9	WZC 849	7·0	—	—	6 45 *m*	245
,, 18	BD − 8°5912	6·4	7 12 *e*	27	—	—
,, 23	26 Arietis	6·1	11 25 *e*	41	0 16* *m*	290
,, 24	WZC 189	6·9	7 57 *e*	92	—	—
,, 27	BD + 27°880	7·0	4 55 *e*	68	—	—
,, 27	136 Tauri	4·5	6 48 *e*	74	8 5 *e*	281
,, 27	BD + 27°943	7·0	11 8 *e*	150	—	—
,, 27	BAC 1918	6·1	11 22 *e*	69	0 26* *m*	311
,, 29	39 Geminorum	6·1	0 11 *m*	84	1 17 *m*	311
,, 29	40 Geminorum	6·3	0 35 *m*	109	1 46 *m*	286
,, 29	BAC 2514	6·0	4 16 *e*	43	4 50 *e*	330
,, 30	WZC 550	6·8	5 23 *m*	139	—	—
,, 30	μ^2 Cancri	5·4	7 19 *m*	178	—	—
,, 30	η Cancri	5·5	4 1 *e*	74	4 48 *e*	311
,, 30	WZC 587	6·7	7 13 *e*	129	—	—
,, 30	39 Cancri	6·5	7 17 *e*	78	8 16 *e*	317
,, 30	40 Cancri	6·5	7 19 *e*	85	8 22 *e*	310
,, 30	BAC 2910	6·4	7 42 *e*	149	8 33 *e*	246
,, 30	WZC 594	6·7	7 43 *e*	130	—	—
,, 30	WZC 595	6·7	8 9 *e*	165	—	—
,, 30	WZC 597	7·0	8 12 *e*	74	—	—
,, 31	BAC 2991	6·1	1 42 *m*	95	2 44 *m*	324
,, 31	7 Leonis	6·2	9 29 *e*	139	10 35 *e*	275
,, 31	11 Leonis	6·6	10 33 *e*	93	11 39 *e*	327

From New to Full disappearances take place at the Dark Limb, from Full to New reäppearances.
The asterisk indicates the day following that given in the date column.
Attention is called to the unusual number of occultations in the last week of January.

TABLE 57. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m. s.	° ′		d.	
T Cassiopeiae	0 18 37	+55 19	6·7 to 12·5	443	1914—Dec. 24
R Piscium	1 26 15	+ 2 26	7·0 to 14·0	344	,, Dec. 12
U Persei	1 53 57	+54 24	7·0 to 10·9	317	1915—Feb. 14
W Andromedae	2 12 11	+43 55	6·5 to 13·8	395	,, Feb. 9
Mira Ceti	2 15 3	− 3 21	2·0 to 9·6	331	,, Feb. 11
R Leonis Min.	9 40 29	+34 54	6·2 to 1·3	371	,, Jan. 14

Special attention should be given to Mira Ceti, which will be approaching Maximum in January. It must be observed as early in the evening as possible.

Night Minima of Algol $9^d\ 4^h\cdot5$ *m*, $12^d\ 1^h\cdot3$ *m*, $14^d\ 10^h\cdot1$ *e*, $17^d\ 6^h\cdot9$ *e*, $29^d\ 6^h\cdot2$ *m*. Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of β Lyrae January $9^d\ 2^h$ *m*, $22^d\ 0^h$ *m*. Period $12^d\ 21^h\ 47^m\cdot5$.

For Titan and Japetus E., W. stand for East and West elongations, I. for Inferior (North) conjunction, S. for Superior (South) conjunction. Titan $3^d\ 5^h{\cdot}0\ e$ E., $7^d\ 4^h{\cdot}1\ e$ I., $11^d\ 1^h{\cdot}2\ e$ W., $15^d\ 0^h{\cdot}5\ e$ S., $19^d\ 2^h{\cdot}4\ e$ E., $23^d\ 1^h{\cdot}8\ e$ I., $27^d\ 10^h{\cdot}7\ m$ W., $31^d\ 10^h{\cdot}0\ m$ S.; Japetus $20^d\ 5^h{\cdot}0\ e$ E.

URANUS is invisible. In conjunction with Sun February 1st.

NEPTUNE is in opposition on 20th, diameter 2″. $2\frac{1}{2}°$ S. of Moon at midnight on 2nd.

DOUBLE STARS AND CLUSTERS.—The tables of these given three years ago are again available, and readers are referred to the corresponding month of three years ago.

VARIABLE STARS.—Stars reaching their maxima in or near January 1915 are included. The lists in recent months may also be consulted.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant.			Remarks.
	R.A.		Dec.	
	°		°	
Jan. 2-3 ..	230	+	53	Brilliant, swift; long paths.
" 3 ..	156	+	41	Swift.
" 11-25 ...	220	+	13	Swift, streaks.
" 17 ...	295	+	53	Slow, bright.
" 17-23 .	159	−	27	Swift.
" 25	131	+	32	Swift.
" 29	213	+	52	Very swift.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

STATISTICS OF STELLAR PARALLAXES.—Mr. O. R. Walkey has kindly sent me a reprint of his paper in *Astr. Nachr.*, No. 4754. He has classified all reliable measures of parallax. He admits that the resulting statistics are apt to be misleading as regards the stellar system as a whole; for, while all the bright stars have been measured for parallax, only those faint ones that have considerable proper motion have been measured. The results support those that have been deduced by other methods. Thus the absolute luminosity is greatest for stars of the B type, and diminishes in succession for Types A, G, K, M. There is, perhaps, some evidence for the separation of the M stars into giants and dwarfs, as first suggested by Professor H. N. Russell. Three hundred and seventeen of the stars discussed are brighter than the Sun, and two hundred and twenty-seven fainter. He puts fifteen stars within thirteen light-years (parallax $\frac{1}{4}''$), and considers that the list down to this point is complete, but that more stars are still to be added to the forty-three lying within twenty light-years.

He has not included radial velocities in his statistics, but the cross velocities are tabulated, and support the conclusion, now generally accepted, that the speed increases with advancing age. He gives twelve miles per second for the Type A stars, twenty-five miles for Types F and K, thirty miles for the solar type G, so that our Sun's velocity is far below the average velocity of its class.

Direct parallax measures do not take us very far into the stellar system. We can make a much deeper plunge into space by using the results of proper motion combined with measures of radial velocity where these are available.

THE NINTH SATELLITE OF JUPITER.—The discovery of this very tiny body, which is of the 19th magnitude, was briefly announced by telegram last July. Some further particulars, confirming its satellite character, are contained in the October number of the *Publications of the Astronomical Society of the Pacific*. The object was first photographed on July 21st last by Mr. Seth B. Nicholson, using the Crossley reflector, and giving a two hours' exposure: it was found 15′ east, 6′ south of the eighth satellite, and one magnitude fainter. It was photographed daily till the end of July, and on August 21st, 22nd, 23rd. The orbit was deduced by Leuschner's method, and proved to be an ellipse with a period of nearly three years, so that it is still further from Jupiter than the eighth, whose period is two years. The solar perturbations must be extraordinarily large, and the stability of the orbit uncertain. Like VIII, its motion is retrograde: this was to be expected, for Mr. Jackson recently showed that such motion was stable at a greater distance from the primary than direct motion. The eccentricity and inclination of the orbit of IX are not yet given, but are probably large. It goes four times round Jupiter, while Jupiter goes once round the Sun. The number of synodic months in a Jovian year is, however, five, owing to the retrograde motion. Jupiter now equals Saturn in the number of known companions, as the existence of Saturn X (Themis) has not been fully confirmed. The same publication contains other interesting matter. Dr. W. W. Coblentz writes on the heat of the stars, as measured with a thermopile attached to the Crossley reflector. As might be expected, the stars of late type show much more heat in proportion to their luminosity than the early types. Thus Arcturus is found to radiate 2·42 times the energy that Vega does. The two stars of Class M, Beta Pegasi and Alpha Herculis, have extremely high heating power. A test of the distribution of energy in different parts of the spectrum was afforded by interposing a layer of water, one centimetre thick, which absorbed the long infra-red rays. Sixty per cent. of the energy was transmitted for Sirian stars, forty per cent. for solar ones, twenty-five per cent. for red ones. The planets were also tested. From fifty to sixty per cent. of the light of Venus, Saturn, and Jupiter was transmitted through the water cell, but only fourteen per cent. of the Moon's rays. It was concluded that owing to the absence of an atmosphere, and the low albedo, the Moon's surface gets hotter than those of the planets, and a larger fraction of its energy consists of infra-red rays.

Professor W. S. Adams gives an interesting case of a Sirian star of very low absolute luminosity. This is the ninth-magnitude companion of Omicron Eridani; taking the parallax as 0″·17, the absolute magnitude is 4·8 magnitudes below the Sun.

A communication from Mount Wilson states that RS Boötis has a photographic magnitude range fifty per cent. greater than the visual range; in other words, it gets redder at minimum, which is confirmed by the spectrum at maximum being of Type B8 (Helium), while at minimum it is of Type Fo (Procyon). From Mount Wilson also comes a note on the spectra of stars in the Great Hercules cluster, Messier thirteen. Out of twenty stars examined, one is of Type Ao, six of Type A5, nine of Type Fo, three of Type F 5, one of Type Go: these figures are similar to those of nineteen other stars in the cluster previously published.

Professor Aitken has a note on Epsilon Hydrae. Periastron will be passed in April, 1916. The angular motion is very rapid at this time, 180° being traversed in a year. Spectroscopic determinations of the motion of the principal star in the line of sight will increase our knowledge of the orbit and of the masses and distance of the system. It is to be hoped that advantage will be taken of this opportunity.

ROTATION PERIODS OF SATURN'S SATELLITES.—Some months ago Professor Lowell announced the variability of Tethys and Dione to the extent of a quarter magnitude, the period in each case being the same as that of the revo-

lution. In *Lowell's Bulletin* 64 he announces a similar conclusion in regard to Mimas and Enceladus. Their magnitudes and ranges are given as:—Mimas 12·90 to 13·33; Enceladus 12·33 to 12·67. Both are brightest near the western elongations, agreeing in this respect with Japetus, whose range of variation is greater. It is concluded that all the satellites resemble our Moon in always turning the same face to their primary. This would be a natural consequence of the powerful tidal action of the primary.

CHEMISTRY.

By C. Ainsworth Mitchell, B.A. (Oxon.), F.I.C.

AMERICA AND THE DYESTUFF INDUSTRY.—The stoppage of the supply of aniline dyestuffs from Germany appears to have been felt even more severely in the United States than in this country. Unless the dyes can be imported or rapidly manufactured, the closing of numerous American textile factories will soon be inevitable. Hitherto attempts to obtain fresh supplies from Germany have been fruitless, and the *Metallurgical and Chemical Engineer* (1914, p. 551) has therefore been inquiring of a few prominent American chemists as to the practical feasibility of manufacturing the products at home.

In reply, Dr. Nicholson stated that everything would depend upon the encouragement given by the buyer to the manufacturer, while Mr. Matheson pointed out that the industry was already well advanced as far as regarded intermediate products, such as aniline oil and aniline salts, and that its further advance was contingent upon a supply of cheap benzene.

Dr. Hesse remarked that the United States already produced about a third of its requirements of aniline dyes, but that they were manufactured almost exclusively from intermediate compounds imported from Germany. In the case of these products (including aniline oil, aniline salts, naphthylamine, anthraquinone, and other compounds), Germany controlled the markets of the world, owing to the fact that her factories were interdependent, each of the large number of products being made by interaction with other products, none of which was of use by itself. Hence it would not be sufficient to transplant one of the twenty-two German factories to America, but it would also be necessary to take some part of each of them in order to have a complete and self-contained industry. About seven hundred different dyes were manufactured in Germany, and this would involve the simultaneous use of some three hundred and fifty sets of apparatus, demanding skilled work in every stage. Even if the industry could be transplanted bodily, the profits would not correspond to the expense, effort, and risk involved, seeing that eventually it would hardly be possible to maintain the ground against the competition of an old-established industry of this nature.

In the opinion of Dr. Matos the problem was not one of the lack of skilled chemists, but of the temporary handicap of not having the specially constructed apparatus for the technical processes involved in converting the intermediate compounds into the final products. The primary question was whether sufficient coal-tar was produced in America, and whether higher prices could be obtained for certain products of the distillation of coal-tar than the colour industry could afford to give.

GEOGRAPHY.

By A. Scott, M.A., B.Sc.

DESERTS.—At the Australian meeting of the British Association a number of papers was read in Section C on Deserts and Desert Formations (*Geol. Mag.*, September, 1914). Professor Gregory defined a desert as a country unoccupied on account of arid climate. Deserts arise through a combination of causes, the chief being climate, the geological structure—surface rocks permeable and crumbling to coarse-grained deposits—and geographical conditions, *e.g.*, plateau land with an escape for water by drainage to surrounding [illegible]. With regard to climate, it is not only the [illegible] rainfall which is important, but also its distribution throughout the year, as well as the rate of evaporation. Desert soils often contain an excess of potash and lime owing to the small amount of leaching. The Australian soils, however, are remarkable for their low phosphate content, the percentage amounts varying from ·047 to ·06 per cent., while European soils average ·098 and American ·116. Elsewhere the subsoil has generally less phosphate than the soil, but this is not the case in Australia. This low phosphate content has been explained as due to the comparative scarcity of mammalian life, which is the source of the phosphate.

Dr. W. F. Hume discussed the physiography of arid lands with special reference to Egypt. The five chief features of the latter country, the oases, the Libyan desert, the Nile valley, the Wilderness of Sinai, and the coastal plains, were explained in terms of their geological history, and the conclusion reached that "the surface structure of an arid land is not only a direct reflex of its geological structure, but also of former climatic changes." There is abundant evidence of a former pluvial period in Egypt, but such a period, as pointed out recently by Professor Gregory (*Geog. Journ.*, February-March, 1914), is long prehistoric.

The features which are typical of most desert regions, whatever their origin and history, were summarised, and they include: evidence of wind erosion and the formation of plateaux, with intense scouring of the surface by sand-grains; the formation of dunes, sheltered places, and of pillars of harder materials (often undercut at their bases); the wearing of pebbles into the form of dreikanter; the breaking up of rocks by the great temperature variation and the fracturing and flaking off of surface zones; the formation of deposits of various oxides leached out of rocks and precipitated by evaporation at the surface.

Half deserts, with their brief but intense rains, are characterised by deep cañon valleys, saw-back ridges, salt marshes, great enclosed talus, and so on.

Mr. H. J. L. Beadnell described the dust dunes of Northern Egypt as deposits of loess, and showed that a desert formation interstratified between two alluvial deposits did not necessarily postulate any climatic change. Professor Walther dealt with the action of wind and water as agents of denudation in arid regions.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

ARCHAEAN GEOLOGY IN CANADA.—In 1887 a memoir, now become classical, on the Geology of the Rainy Lake Region of Canada, was published by Dr. A. C. Lawson. This memoir caused a fundamental revolution in the ideas of geologists concerning the relations of the various Archaean rocks of Canada, and indeed of the whole world. Before the publication of the Rainy Lake memoir the great masses of granitoid gneiss, known variously as the Ottawa Gneiss, the Fundamental Gneiss, or the Laurentian Gneiss, were believed to consist of metamorphosed sediment, and to be the basement upon which all other rocks rested. Dr. Lawson's great achievement was to show that this so-called Fundamental Gneiss is really a plutonic igneous rock, intrusive in, and later than, the metamorphic rocks with which it is associated. Dr. Lawson described two series of metamorphic rocks into which the gneiss was intruded: the Keewatin, consisting mainly of volcanic rocks; and, below this, the Coutchiching, a series of metamorphic sedimentary strata free from volcanic admixture. This interpretation of Canadian Archaean geology has been favourably received by geologists, with the exception of the Coutchiching Series, the stratigraphical position of which was regarded as doubtful. In view of the economic importance of the Archaean rocks of Canada, it was felt that this point ought to be settled; and accordingly the Geological Survey of Canada asked Dr. Lawson to resurvey the Rainy Lake area in the light of the new observations of the last twenty-five

years, and under the more favourable conditions of study and travel now available. The result of this work is a most interesting and important new publication by Dr. Lawson entitled "The Archaean Geology of Rainy Lake Restudied" (Memoir No. 40, Geological Survey of Canada, 1913). The results of the new survey may be briefly summarised as follows. The stratigraphical position of the Coutchiching Series, determined in 1887 as underlying the Keewatin, is fully confirmed. Furthermore, the gneisses formerly grouped under the inclusive term "Laurentian" have been found to belong to two widely separated periods of time within the Archaean. This result has also become apparent in recent years to workers on the Archaean in other areas. For the older of these periods the name "Laurentian" is retained, and for the later period it is proposed to use the term "Algoman," from the old district of Algoma. Two other series of rocks were discovered: one, known as the Steeprock Series, consists of sediments and volcanics, including several hundred feet of fossiliferous limestone, and containing the oldest fossils at present known; the other new series is the Seine, comprising conglomerates, quartzites, and slates. These two series are tentatively correlated with the Lower and the Upper Huronian of Lake Huron. After the deposition of the Seine Series the region was again invaded by great intrusions of granite and syenite gneiss, for which the term "Algoman" has been proposed, to distinguish them from the Laurentian gneisses of much older date.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

AUSTRALIAN WEATHER FORECASTS.—The average percentage of the official weather forecasts issued by the Commonwealth Meteorologist, which have been verified from the inception of the Meteorological Bureau on January 1st, 1908, to December 31st, 1912, is as follows:—

Western Australia ...	87·6	Victoria	88·1
Southern Australia ...	86·3	Tasmania	84·5
Queensland	88·7	Ocean Forecasts	83·8
New South Wales ...	88·1		

The percentage of verification for the whole Commonwealth has thus been 86·7. If the low amount obtained in 1908, which may be attributed to the initiatory and unsettled state of the Service, had not been taken into account the percentage would have been 88·0.

The success of the forecasts during the last four years is no doubt due to the system under which the forecasts are made. The Australian differs from others in that, while the responsibility of issuing forecasts is deputed to an individual in other lands, these are formulated on a consensus of opinion of officers experienced in forecasting from all of the States. These officers each have charge of a branch of work in the Central Bureau, but at noon each day they meet and discuss with the Commonwealth Meteorologist the various charts that have been prepared up to that hour from meteorological observations received from all parts of Australia. After studying the data each officer simultaneously writes out his forecast for, say, Western Australia. The Commonwealth Meteorologist then reads his written opinion, maintains, adds to, or modifies his forecast, according to the views of the officer from that State. The urgency of getting the forecasts as early as possible precludes lengthened discussion, for forecasts for all the States must be despatched from the Central Bureau between 12.15 and 12.30 p.m.; but any points at variance are fully investigated after despatch, old examples, types, and records are fully compared, and, if necessary, any particular forecast may be intercepted and altered; but so well does the system work that it is very seldom indeed found necessary to change the wording of any forecast when once it has left the Office.

MICROSCOPY.

By F.R.M.S.

III.—THE COMMON EARWIG (*FORFICULA AURICULARIA*) (*continued from page* 402).—An interesting addition to the remarks which have been made upon the structure of the Common Earwig is given in the present number (see Figure 417). It consists of photographs of all the British Earwigs, and they have been taken and kindly lent for reproduction by Mr. W. J. Lucas—well known for his work on British Dragon Flies—who has also paid considerable attention to other insects, including those in question. The males of each species are shown, and they are magnified about two and a half times. *Labidura riparia*, as compared with our common species of Earwig, is a veritable giant. It is found on the South Coast, and is not very familiar to those who are not specially interested in Earwigs.

IV.—THE DRAGON-FLY (*AGRION PUELLA*).—The eggs are deposited in the tissue of water weeds. Their length is about 1·3 millimetres and the greatest breadth is 3·5 millimetres. They are quite colourless and semi-transparent, and form a cylindrical sac, with one end pointed and the other rounded. Under favourable conditions of temperature they hatch in about four weeks. From the egg comes the pronymph, as it is called, which very soon changes its skin, giving rise to the nymph. The casting of the embryonic wrapping is not a moult in the strict sense of the term, and it would be more correct to assume that the process of hatching takes place in two stages. The nymphs swim very freely.

The species *Agrion puella* (see Figure 418) is a small one, and suitable for microscopical work. As the nymphs are carnivorous, it is advisable to keep them separate. In their early stages Infusoria and Water-fleas, and later on freshwater Shrimps and Tadpoles, form a suitable diet. Various species of Dragon-flies can be recognised in the nymph stage, and in the one which we are considering there are three pointed semi-transparent flakes projecting from the hinder end of the body, which act as tracheal gills. The creature can capture only slow animals by pursuit, but, escaping notice owing to its dark colour and motionless attitude, it is able to seize its prey by an arm-like appendage of the head. This (see Figure 419) is a modification of the second pair of maxillae, which in other insects, we saw, formed the labium. In the Dragon-fly nymph this is carried on a jointed arm with a pair of claws at the tip.

The respiration of the nymph varies slightly according to the family. In Libellulidae a pair of large spiracles are located on the dorsal region behind the head, between the narrow prothorax and mesothorax. In *Agrion puella* these spiracles are hidden, unfortunately, but can in isolated cases be observed only by careful examination, whereas by dissection another pair can be made out (see Figure 420).

For some time entomologists were under the impression that these spiracles were closed during the aquatic period, and various experiments showed that the nymph, when under water breathes through its tail, and when out of water through its spiracles, that is to say, its true aërial breathing organs.

In his valuable notes, Dewitz showed that this was not true, and that respiration can be carried out in several ways. By employing various experiments he showed that the rectal respiratory movements were more effective than tracheal movements,* but in young nymphs the thoracic spiracles are not pervious, whereas in older nymphs they were ready for transformation, and acted in the ordinary way.

To prove this he closed the rectum of young nymphs with collodion, and by carrying out the same methods in older nymphs ready for transformation he found that when either the rectum or spiracles were closed the nymph lived, but on closing both the nymph died.

* *Zoolog. Anz.*, Bd. XIII, 1891, pages 500-4, 525-31.

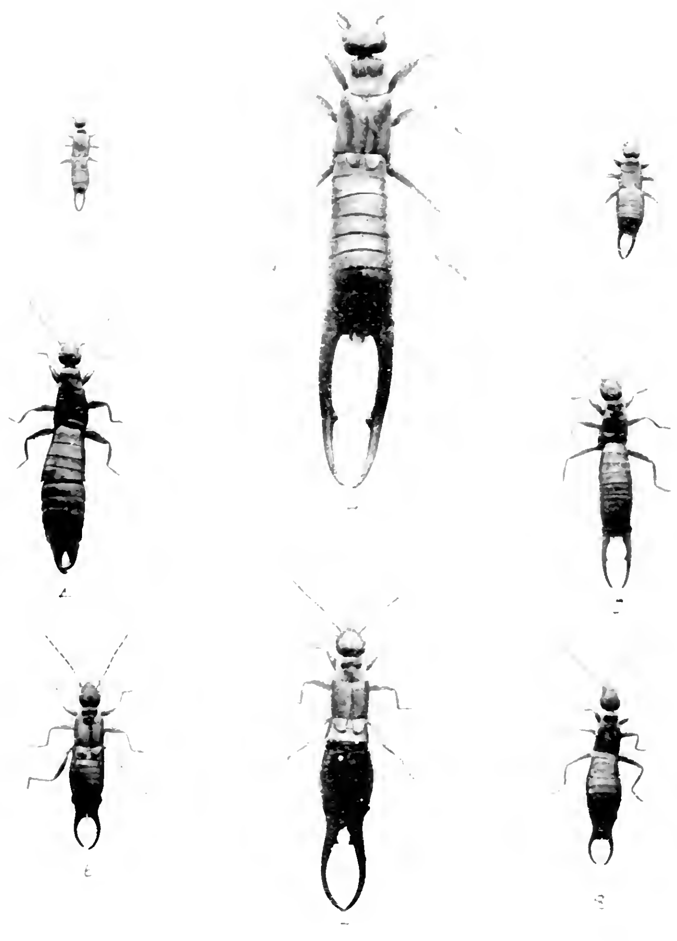


Figure 417. British Earwigs [illegible] × about [illegible].

1. *Labia minor.*
2. *Labidura riparia.*
3. *Prolabia arachidis.*
4. *Anisolabis annulipes.*
5. *Apterygida albipennis.*
6. *Forficula auricularia.*
7. *Forficula auricularia* var. *forcipata.*
8. *Forficula lesnei.*

Figure 418. Nymph of Dragon-fly (*Agrion puella*) in latter stages of developments. × about 12.

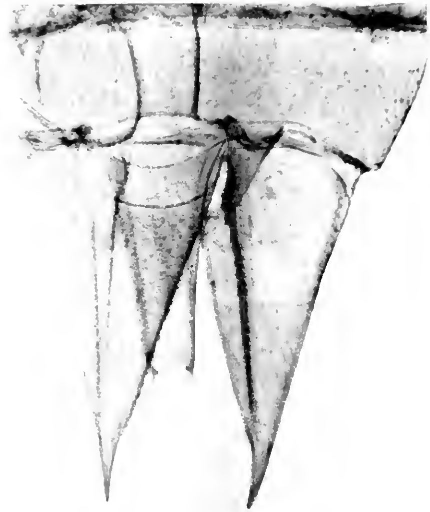


Figure 420. The thoracic spiracles of nymph of Dragon-fly (*Aeschnis grandis*), seen as two tubes immediately under the last pair of growing wings. × about 30.

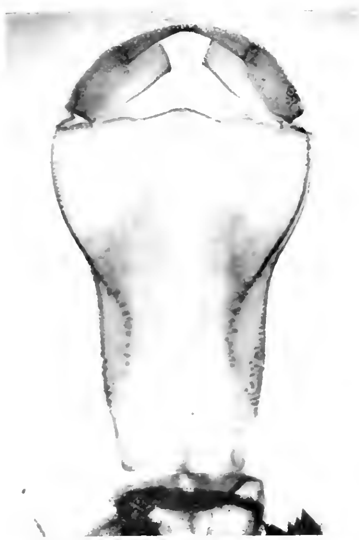


Figure 419. Appendage of Head of Dragon-fly (*Aeschnis grandis*). × about 11.

Figure 421. Abdominal tip of nymph of Dragon-fly (*Aeschnis grandis*). × about 30.

It is interesting to note that young nymphs of *Agrion puella* have the thoracic spiracles to a certain extent functional, and Dewitz supposed that the muscular apparatus for inspiration by the spiracles was not fully developed, and this explains to some degree why these spiracles cannot be made full use of, and only used in a small degree.

In older nymphs of *Agrion puella* the spiracles also become wholly functional, and the nymphs can be observed to creep up plant stems, head foremost, throwing the body into a horizontal position when the surface of the water is reached, to expose the spiracles to the air. Though the spiracles are often used during at least the later part of the nymph's life, they cannot, of course, be employed when the nymph is actually submerged; hence other means of respiration are required in addition to that obtained by the spiracles.

Thus the nymph of *Agrion puella* has at its tail-end the three leaf-like appendages known as "caudal lamellae" (see Figure 418), and these are closely connected with the tracheal system. They extract air from the water, and the nymph breathes by means of them; further, they are of great service in swimming.

Each lamella or leaflet is ramified by a network of air tubes, which extract oxygen from the dissolved air contained in water, and pass this oxygen forward to the main tracheae, which in turn supply the chief organs of the body.

In other species of nymph the abdomen ends in five valves, three of which are commonly larger than the others, and can be brought to a point or widely separated (see Figure 421). When open they disclose the outlet of the main intestine guarded by three fleshy folds, corresponding to the three valves; within them is a large chamber (the rectum) the wall of which exhibits an extremely complicated structure.

Longitudinal bands are present, six in number, separated by thin and flexible membranes, which seem to be present to allow for great distension without risk of damage to the delicate epithelium or layer of the skin.

Each of these bands bears a double row of transverse folds, which increase the epithelial surface enormously, and at the same time the number of tracheal branches. The latter enter larger and more regularly arranged air-tubes, which again in turn open into the main trunks running the whole length of the body.

Large volumes of water are drawn into the rectum at intervals, and from these supplies the tracheal tubes draw the necessary amounts for respiration of oxygen from the air taken in. The vitiated water can either be expelled gently, or, when the nymph requires the body to be propelled forwards with considerable force, it makes use of this water.

The *Agrion puella* nymph has rectal gills like those of *Aeschna* besides external gills. Thus we can observe the body swaying from side to side, whereas *Aeschna* nymphs come to the surface often, and take in air directly through the large intestine by means of the rectal opening. This can be seen to be carried out most frequently when the water is very foul. A stream of water does pass in and out of the rectum of *Agrion* nymphs, but there is no special apparatus present, as in *Aeschna*, to prevent the ingress of foreign particles, which would eventually close up the opening when sufficient had accumulated. If rectal respiration is made use of at all, it must be of minor importance, for in nymphs deprived of their lamellae contractions of the rectum do not take place.

Possibly, but not probably, respiration may be effected by air being taken in through the skin.

(*To be continued.*)

W. Harold S. Cheavin, F.M.S., F.E.S.

DEATH OF DR. M. C. COOKE.—Our readers will be sorry to hear of the death at Southsea on November 12th of this well-known authority and writer on botanical and natural history subjects, especially those in connection with the microscope. He was born on July 12th, 1825, and was therefore in his ninetieth year, at a village in Norfolk. He was educated in the village school until he was nine, and then by his uncle, a dissenting minister. He was usher in a boys' school, afterwards clerk to a lawyer, and for nine years a certificated teacher in a national school. He had an appointment in 1860 to the India Museum, was transferred to Kew Gardens for botanical work, and was especially engaged in the Cryptogamic Department. He was M.A. (Yale, 1873), M.A. (St. Lawrence, 1870), LL.D. (New York, 1871), A.L.S. (1877), Gold Medal Linnean Society (1903), F.R.H.S. (1902), and was awarded the Victoria Medal of Honour by the Royal Horticultural Society. He was the author of over forty books on various botanical and natural history subjects. Among them "Illustrations of British Fungi," in eight volumes with coloured plates; also an "Introduction to the Study of Fungi" 1895. His work on "British Freshwater Algae," with coloured illustrations, published 1882-4, and an "Introduction to Freshwater Algae," 1890, in the International Scientific Series, are probably more used than any other works in English on the subject. His work on Desmids and the "Handbook of British Fungi," 1871, though somewhat out of date, may still be considered standard works of reference. Many of his books are of a distinctly "popular" character, and, with papers innumerable and valuable contributed to various natural history societies, have done probably more to popularise natural history study, and especially that in connection with microscopy, than those of any other writer. In a recent letter to the Quekett Microscopical Club, of which he was one of the principal founders, he observed that he had made about fifteen thousand drawings of various natural objects for his books and other purposes. He was an honorary member of some fifteen scientific societies, British and foreign.

J. B.

THE QUEKETT MICROSCOPICAL CLUB.—The five hundred and first ordinary meeting of the Club was held at 20, Hanover Square, W., on Tuesday, October 27th. In the absence of the President, who had attended the meetings of the British Association in Australia, and had not yet reached England, the chair was taken by Mr. D. J. Scourfield, F.R.M.S., Vice-President.

After the formal business, additions to the Library and Cabinets since the five hundredth meeting were announced, the latter comprising sixty-one microscopic slides and two sets of physiological preparations, with descriptions. The thanks of the Club were accorded to the various donors.

The Chairman read a letter conveying the information of the death of Dr. Arthur Mead Edwards, of Newark, New Jersey, U.S.A. Dr. Edwards was the oldest honorary member, having been elected in January, 1868. He was then President of the American Microscopical Society of New York. At his death he was seventy-eight years of age. He was chiefly interested in the study of the Diatomaceae.

The report of Mr. C. F. Rousselet, F.R.M.S., delegate from the Club to the Conference of the Corresponding Societies of the British Association at Havre, was read by the Secretary. The Meeting began on Monday, July 27th, with an address of welcome by Mons. A. Gautier, the President, which was replied to by Sir W. Ramsey on behalf of the English members. There was a series of meetings for the rest of the week, with an excursion up the Seine as far as Rouen, visiting various historical places on the way. The success of the gathering, however, was interfered with by the critical state of political matters, and the Meeting was hurriedly broken up on Saturday on the promulgation by the French Government of the general mobilisation decree.

A paper by Mr. A. A. C. Eliot Merlin, F.R.M.S., was read (in part) on "The Minimum Visible." It commenced with a reference to the address of the President of the Club at the annual meeting, in which a point was raised respecting

the size of the smallest particles that can be seen with the microscope. Reference was also made to a paper, recently given at the Club on "Some Notes on the Structure of Diatoms," in which "pores" had been described as occurring on the valves of certain diatoms, estimated to be about 1/200000th of an inch in diameter. It stated: "As our knowledge is very exact and definite indeed on this subject, it may prove of interest to deal with the question in some detail. As a matter of fact, when a particle properly illuminated is just visible with a given objective, if the aperture be cut down by means of an iris diaphragm, placed above the back lens, so that the particle just ceases to be visible, and the N.A. to which the objective has been reduced is measured, then the dimensions of the particle can be exactly ascertained from the Antipoint Table, published by Mr. Nelson in the *Journal of the Royal Microscopical Society*." The paper was of a very valuable but technical character, and does not lend itself to an efficient summary, but will be reproduced in full in the next issue of the *J.Q.M.C.* Messrs. Brown, Blood, and Ainslie made some remarks on the subject, and a very hearty vote of thanks to Mr. Merlin was accorded.

Mr. Rousselet exhibited under microscopes two species of African volvox, showing the sexual state, and a short paper was read, detailing the remarkable history of their discovery. The identical species had been described from specimens showing the vegetative condition only, by Professor West, some time ago at the Club, but the sexual state of neither had then been found. Subsequently Mr. Rousselet had discovered these among other plankton organisms in some tubes sent to him by Professor Jakubski, of Lemberg, and which had been collected from another part of Africa. By this means the complete descriptions of the two species, *Volvox africanus* and *V. Rousseleti*, had been made good from a quite unexpected source.

Mr. W. E. Watson Baker exhibited under a microscope a mounted specimen of the egg and very young larva of the Anopheles mosquito. The organism is rarely found in these conditions. A vote of thanks was passed to both Mr. Rousselet and to Mr. Baker for their exhibits.

J. B.

PHOTOGRAPHY.

By EDGAR SENIOR.

DEVELOPMENT WITH FERROUS OXALATE.—The method of development in which organic iron salts are employed was originally introduced by Mr. Carey Lea and Mr. W. Willis, junr., in 1877; and, although the method was never used to any great extent in this country, it was largely employed both on the Continent and in America for the development of exposed plates, while at the same time it was practically the only developer available for use with bromide papers until the advent of amidol and some of the newer developers. A considerable amount of attention has lately been drawn to its employment for this latter purpose, in case of any difficulty arising with regard to the supply of amidol, or any great increase in its cost, since ferrous oxalate can be prepared quite easily and cheaply by the photographer himself, the potassium oxalate being the most expensive of the constitutents used. Development with ferrous oxalate consists in applying to the exposed plate or bromide paper a solution of ferrous oxalate in potassium oxalate, since the ferrous salt itself is a lemon-coloured powder which is almost insoluble in water, but soluble in a solution of neutral potassium oxalate, producing a deep-red coloured liquid. In the preparation of the developer the neutral potassium oxalate must be employed, as the acid oxalate, known as salts of sorrel, would require its oxalic acid to be neutralised by means of potassium carbonate before it would be available for use. The method which was originally adopted in the formation of the oxalate developer consisted in the addition of ferrous oxalate to a warm and saturated solution of neutral potassium oxalate, the oxalate being added until a small portion of the ferrous salt remained undissolved, as by this means the ferrous oxalate developer was obtained in its most concentrated form. Another method due to Sir William Abney consisted in adding the ferrous oxalate to a cold, saturated solution of potassium oxalate, and allowing the mixture to remain, with occasional shaking, for twenty-four hours, when the clear liquid was decanted off for use. A method, however, which was first introduced by Dr. Eder consisted in mixing together three parts of a cold, saturated solution of potassium oxalate with one part of a solution of ferrous sulphate of the same strength. The addition of various foreign substances to the oxalate developer has also been recommended at various times, but the one found most useful, especially in portraiture, was that in which a few drops of a solution of "hypo" of the following strength was added:—

"Hypo"	1 part
Water	200 parts

(*To be continued.*)

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc.

THE *X*-RAY SPECTROMETER.—The instrument employed in such investigations as the preceding is described in an illustrated article in *Nature* for October 22nd, 1914. The object of the *x*-ray spectrometer is to determine θ in any given case. If the *x*-rays are kept of the same wave-length λ, then the space l between the planes rich in atoms can be compared together for different directions in the same crystal and for various crystals; and, if λ be known, then l can be computed. If, however, the crystal face employed be unchanged the wave-lengths of rays from different anticathodes can be found. The new instrument has parts corresponding to those of an ordinary spectrometer. As a source of radiation the anticathode of an *x*-ray tube is used. The anticathode is set at right angles to the cathode stream, and is presented almost edgeways to the direction of a slit, which admits the *x*-rays on to the crystal face. The source and slit correspond to the collimator of an ordinary spectroscope. The crystal is mounted on the rotating central table of the instrument with the face to be studied placed vertically. The line of the central axis of the spectrometer passes through this crystal face, and a vernier attached to the table records its position. The reflected *x*-rays pass from the crystal into the ionisation chamber, which corresponds to the telescope of an ordinary spectrometer, and is similarly provided with a vernier to read its position.

The ionisation chamber is an insulated metal vessel containing some heavy gas. An internal electrode is connected by an insulated and shielded wire to a gold leaf electroscope. The chamber is kept electrically charged, and when the reflected *x*-rays enter the chamber, and make the contained gas conduct, the gold leaf indicates their presence by its motion. Since the electroscope with its observing telescope and illuminating arrangements must be kept still, the connection with the electrode in the ionisation chamber is made at a point on the downward prolongation of the central axis of the spectrometer; so that when the chamber is swung round into different positions the connecting wire is not disarranged.

CAN THE RARE GASES BE PRODUCED BY ELECTRIC DISCHARGE?—In 1913 Collie and Patterson described experiments which seemed to show that when hydrogen at low pressure was subjected to the action of the electric discharge neon was produced. This experiment, however, yielded negative results when tried by Strutt, who could detect no trace of either neon or helium in his apparatus. Two papers on this subject appear in the *Proceedings of the Royal Society* for August 1st, 1914. In the first Merton finds that, if leakage of air into the tubes

FIGURE 42[illegible]. The Penguins' Promenade at Cape Adare.

FIGURE 42[illegible]. Ice Boulders hurled up the beach by a heavy swell.

See page 4[illegible].

From "Antarctic Adventure," by Raymond E. Priestley. By [illegible] Mr. T. Fisher Unwin.

Figure 424. The female Slow-worm on the right side of the picture is laying her third egg. On the left is a young Slow-worm emerging from the first egg laid.

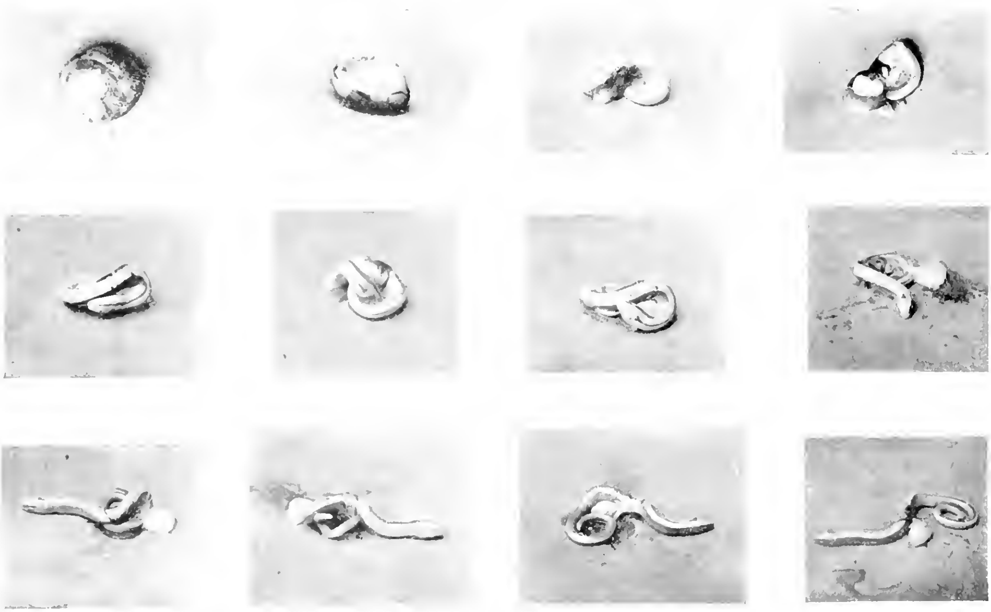


Figure 425. A series of twelve pictures showing a young Slow-worm freeing itself from the egg-membrane.

The Hatching of a Slow-worm's Egg. By the courtesy of the Editor of *Wild Life*.

is prevented, then no rare gases are found, and attributes the presence of argon in some experiments to this cause. In the second paper Collie studies the effect of the bombardment of uranium by cathode rays in hydrogen, and finds that, under certain conditions, the gases neon, helium, with a minute trace of argon are present. The subject is still under experiment, and one can only suspend judgment until some crucial test has been applied.

RADIO-ACTIVITY.

By Alexander Fleck, B.Sc.

SOURCES OF RADIUM.—For a long time after the discovery of radium the principal source of that valuable element was the small town of Joachimstal, in Bohemia, where the Austrian Government has a uranium factory. There are mines near there producing pitchblende; but the "dump" heaps, where the residues obtained in the purification of uranium had for years been placed, are of much greater value. The amount of radium that could be produced annually from this locality is not known, but, at any rate, the European war will have cut off this country from that source at present. Pitchblende has also been found in Cornwall; but there, again, working the refuse heaps seems to be of more commercial value than mining the mineral.

Autunite, a mineral composed of uranium phosphate, has never been found in quantities sufficiently large or concentrated to enable commercial work to pay. This remark applies to the material found in the north of Portugal, as well as to that found in the type locality of Autun, in France. Uranium minerals have been found at various parts of the world, but, with the exception mentioned below, all of them have been found in either too low grade or else in too small quantities. The exception referred to is carnotite, which comes from Colorado. It is a mineral containing uranium, potassium, and vanadium, and the main quantity occurs as the coating of the grains of an almost horizontally bedded sandstone. The mineral, however, is not found uniformly distributed throughout the sandstone, but occurs in "splashes" alternating with barren rock. This field, which is said to occupy a circular area of about one hundred and fifty miles in diameter, and includes part of Utah, seems destined to take an important place in the world's production of radium.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A., LL.D.

HIBERNATION OF MEADOW JUMPING MOUSE.—Dr. H. L. Babcock has made some observations on *Zapus hudsonius*, the Meadow Jumping Mouse of Massachusetts. A captive specimen, which seemed to grow fat towards the end of summer, began, from August 28th onwards, to remain indoors intermittently when the nights were becoming cold. On November 1st it retired for the winter, but was found dead when the nest was opened in June. It probably died of cold, for it had made its nest in the side of a large sod placed in one corner of the cage, though it might easily have found a less exposed situation. The observations made during the period before retiring to rest seem to show that the torpidity comes on gradually—at first for only a night at a time—and that temperature is not the only factor affecting the onset of the hibernation.

KING SALMON IN FRESH WATER.—We notice in a recent report on the endoparasites of Kamtschatka Salmonidae a circumstantial confirmation of the statement that the species of Oncorhynchus, or Pacific King Salmon, do not eat in freshwater, and exhibit degeneration of the food canal. As is well known, the King Salmon ascend the rivers only once, usually in their third or fourth year, and die after spawning. There is no return to the sea as in the case of our Salmon. But it was the precise statement in regard to the alimentary tract that interested us: "The intestine and the stomach shrivel up, and the mucous membrane degenerates."

LIMPET'S FEEDING HABITS.—Dr. J. H. Orton has published an interesting figure, which shows a Limpet on its "home," and radiating from this a number of food-paths which it had eaten in a growth of green algae (chiefly young Enteromorpha) on a cement pile. The paths are marked by fine lines made by the teeth of the radula. In several cases, as the figure shows, the Limpet had evidently travelled beyond the end of the path formerly eaten before beginning to browse again, and had yet returned to its home in safety. In some cases the spatting of acorn-shells (*Balanus balanoides*) along the otherwise bare paths makes them so evident that they are easily seen from some distance away.

WILD LIFE.

As foreshadowed in our notice of some months ago, the recent numbers of *Wild Life* have not consisted of so many pages, but the material which they have contained in no way falls short of the standard which has been set in the past. The September number practically consists of notes and photographs of the kingfisher in the many aspects of its daily life. In the October number a special feature is made of British reptiles, and photographs of all the species by Mr. Douglas English are given. By kind permission we reproduce the illustrations showing the egg-laying of the blindworm and the almost immediate hatching of the egg (see Figures 424 and 428). Careful drawings of this were given in "Eton Nature Study", in 1903, but we do not think that photographs of this interesting occurrence have been successfully taken and reproduced before. The same number contains an article on the Grey Lag Goose, and in the issue for December Mr. Russell Roberts will conclude his remarks on the black rhinoceros. There will also be articles on the raven, the hare, the pied wagtail, and British clear-wing moths, with the usual notes from the Zoölogical Gardens, which are contributed by Mr. E. G. Boulenger.

REVIEWS.

CHEMISTRY.

Some Fundamental Problems in Chemistry: Old and New.—By E. A. Letts, D.Sc. 235 pages. 44 illustrations. 9-in. × 6-in.

(Constable & Co. Price 7/6 net.)

The object of this book is to link up the chemical theories of the last century with those that have followed the discovery of the inert gases and the disintegration of the radio-active elements. The material for such a survey is ample, for many of the discoveries of to-day are now seen to have been foreshadowed, although dimly, in the observations put forward in support of theories now discarded. The new chemistry, too, can claim the fulfilment of prophecies, and the prediction of the discovery of the gas neon is as striking as Mendeléef's prediction of unknown elements to fill gaps in the periodic table.

Dr. Letts tells this story of the evolution of chemistry into its present position in a simple manner, which holds the attention of the reader from the outset. The subjects

discussed include the periodic law, the transmutation of elements under the influence of radio-activity, Sir Norman Lockyer's views on inorganic evolution, and the theory of Arrhenius upon the sources of the energy of the Sun. Some idea of the extent of the ground covered may be gathered from the fact that room is found for a description of the construction of the micro-balance.

It is a book to be read more than once by every chemist or everyone interested in chemistry.

Chemistry and its Borderland.—By A. W. STEWART, D.Sc. 314 pages. 15 illustrations. 8-in. × $5\frac{1}{2}$-in.

(Longmans, Green & Co. Price 5/- net.)

The scope of this book is very wide, for it gives in a semi-popular form, devoid of formulae, a comprehensive survey over the whole field of modern chemistry. Thus separate chapters are given to immuno-chemistry, chemistry in space, colloids and the ultra-microscope, radium, transmutation, methods of chemical research, and so on. The author is exceptionally successful in making any abstruse points clear, and each subject is treated in such a way that even those whose knowledge of chemistry is of the slightest can follow it easily and with pleasure. Throughout the book we feel that we are reading, not merely a narrative, but that there is also a point of view in the background.

The last chapter, which deals with suggestions for organising chemical research, is interesting, and likely to promote discussion. It is chiefly concerned with the teaching institutions in this country, and rather conveys a suggestion of deprecating the good research work that has been done in connection with industrial problems. A good deal depends upon what is to be regarded as the object of research. If it is mental training, the problems to be solved in the factory may be quite as effective as the preparation of synthetic compounds. Nor do the methods of the teaching institutions necessarily promote any greater originality of thought. The aim is frequently to score well in examination, and many students, after an academic training, are little, if anything, better than the "human testing machines" of the factory. The Institute of Chemistry is doing much to remove the stigma of incompetence from the utilitarian chemist, and in its examinations it endeavours to discover the capacity of a student for original work, and to give him credit for what he has done. It is somewhat strange that Dr. Stewart should have omitted any mention of the work of the Institute; since it is the one body that aims at promoting the efficiency of the chemist, both from the academic and the more narrowly professional point of view.

C. A. M.

PHYSICS.

Report of the National Physical Laboratory, 1913–14.— 144 pages. 5 plates. 1 figure. $10\frac{1}{2}$-in. × 8-in.

(Teddington: W. F. Parrot. Price 2/6)

This report gives a concise statement of the activities of the laboratory for the period of fifteen months, beginning with January 1st, 1913. So condensed an account of the diverse work of this great institution does not lend itself readily to further compression. The routine tests carried out during the year involved the receipt and dispatch of goods to the value of £300,000. The total annual expenditure is about £40,000, three-quarters of this sum being spent in salaries, wages, and so on. It is a remarkable fact that, in spite of the large amount of commercial testing which is carried out, the scientific work of the laboratory is not only of the highest type, but of great volume. The list of papers published by the staff since 1912 occupies nearly nine pages, and includes many memoirs of the first importance. The Director (Dr. Glazebrook, F.R.S.) acknowledges his indebtedness to the heads of departments for the various sections of the report. Both he and they are to be congratulated on their work, and the nation, as a whole, has every cause to be proud of its youthful, vigorous, and rapidly growing physical laboratory.

J. H. V.

POLAR EXPLORATION.

Antarctic Adventure. Scott's Northern Party.—By RAYMOND E. PRIESTLEY. 382 pages. 1 map. 150 illustrations. 9-in. × $5\frac{3}{4}$-in.

(T. Fisher Unwin. Price 15/- net.)

When, during his last antarctic expedition, Captain Scott started on his journey to the Pole, he left behind him a "Northern Party" to explore and to make scientific observations. The members of this party were: Commander Campbell, Surgeon Levick, who was zoölogist and photographer, three men, and Mr. R. E. Priestley, who acted as geologist and meteorologist. The last it is who has written the trenchant account which is before us of their doings. They were landed at Cape Adare, where stores were put ashore for them and a hut erected, which they were left to finish. The first part of the narrative deals with the year which they spent at this spot. The difficulties which had to be overcome in photography, when, in early days, they handled water and developers in a disused hut, where the temperature was ten degrees below freezing, could not be guessed from the many excellent illustrations with which the book is adorned. Two of these we are permitted to reproduce in Figures 422 and 423.

Mr. Priestley comments on the volunteer help which he received, and gives credit to the men, Abbott, Browning, and Dickason, for much of the scientific work accomplished. He says that the Northern Party, arriving in the Antarctic with five sailors and one scientist, may be fairly said to have returned with six scientists, all of whom had done original work in one department or another.

After a time the "Terra Nova" took the party down the coast, and left them to make a sledging expedition. Unfortunately she was unable to return, and the winter had to be faced with practically no equipment and insufficient provisions. The second part of the volume deals with the trials of the six men, and how they successfully came through them.

W. M. W.

NOTICES.

MR. A. W. ISENTHAL, who is the sole partner in Messrs. Isenthal & Co., has been resident in this country for twenty-five years, and is a naturalised British subject. The business is carried on without any outside financial assistance, British or foreign, and the whole of the firm's workmen and works staff consists of British-born subjects. The foreign patents which they exploit at present are of Swiss origin.

THE WELLCOME RESEARCH LABORATORIES.—Dr. Frederick B. Power has retired from the directorship of the Wellcome Chemical Research Laboratories in order to return to the United States of America, where, for family reasons he will make his future home. His period of service dates from the foundation of the laboratories by Mr. Henry S. Wellcome in the spring of 1896. Dr. Power has been succeeded by Dr. Frank L. Pyman.

LONDON NATURAL HISTORY SOCIETY.—The Council of the London Natural History Society invites any Belgian or French refugees interested in natural history to attend the Society's meetings, and offers them the use of the Society's library and collections. The meetings of the Central Society are held at Hall 20, Salisbury House, London Wall, E.C., at 7 p.m., on the first and third Tuesdays of the month. Further particulars can be obtained from J. Ross, 18, Queen's Grove Road, Chingford, N.E.